Chapter One: The Impacts of Climate Change Along the U.S.-Mexico Border

The Southwest Border region is largely characterized by a hot, dry climate. The paleoclimate record indicates past periods of extended drought lasting several decades. Changes in global climate are expected to result in a variety of vulnerability issues for the region. These impacts include: temperature increases in air, land, and ocean; decreased total precipitation; more extreme weather events; decreased snow pack and runoff; insect outbreaks; more frequent and intense wildfires; and sea-level rise and storm surges leading to flooding, salt water intrusion, and erosion in coastal areas.

Global annual average temperature, as measured over both land and ocean surfaces, warmed roughly 1.53°F from 1880 to 2012,[1] and the last decade was the warmest on record. U.S. average air temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895, and most of this increase has occurred since about 1970. Continued warming of the planet is projected to occur as a result of greenhouse gas emissions, although natural variability will still play a role.[2] Recent research has indicated that another 0.5°F increase is expected over the next few decades even if all greenhouse gas emissions stopped.[3] Recorded past and projected future temperature increases also have affected and will affect the climate of the border region, with the greatest increases inland from the coast. The magnitude of temperature increase is greatest during the summer, with more extreme heat days over 100°F and more high nighttime temperatures. Average annual temperature is expected to increase 2-7 degrees F during the middle of the 21st century.[4]

Precipitation is projected to be more variable and to decrease overall in the border region, with decreases on the Pacific coast and parts of the Arizona-Sonora border. The Lower Rio Grande Basin area of the border also could experience precipitation decreases, with a potential decline

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[1] Intergovernmental Panel on Climate Change, "2013: Summary for Policymakers," in *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* ed. T. F. Stocker, D. Qin, D.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley (New York, NY: Cambridge University Press), [HYPERLINK "http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf"].

[2] E. Hawkins and R. Sutton, "The Potential to Narrow Uncertainty in Projections of Regional Precipitation Change," *Climate Dynamics* 37 (2011): 407–418, doi:10.1007/s00382-010-0810-6.

[3] H. D. Matthews and K. Zickfeld, "Climate Response to Zeroed Emissions of Greenhouse Gases and Aerosols," *Nature Climate Change* 2 (2012): 338–341, doi:10.1038/nclimate1424.

[4] M. Wilder, G. Garfin, P. Ganster, H. Eakin, P. Romero-Lankao, F. Lara-Valencia, A. A. Cortez-Lara, S. Mumme, C. Neri, and F. Muñoz-Arriola, "Climate Change and U.S.-Mexico Border Communities," in *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, ed. G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy (Washington, D.C.: Island Press, 2013), 345 ff.

of 700,000 acre-feet of available surface water by 2060.[5] [6] Limited water resources and periodic droughts have been major issues historically in the region, with increasing temperatures and changes in precipitation exacerbating drought consequences.[7] Paleoclimate records for the area show that severe "mega-droughts" have lasted for 50-year periods.[8] The decade of 2001 to 2010 was the warmest in the 110-year instrumental record for the U.S. southwest, with temperatures almost 2°F higher than historic averages, fewer cold air outbreaks, and more heat waves.[9] Droughts and heat waves along the U.S.-Mexico border region are projected to become more intense and cold waves less intense, affecting precipitation, runoff and recharge, food and energy security, and ecosystem and species health. For example, dry conditions coupled with overgrazing can lead to erosion, the spread of invasive plants, and reduced productivity of crops such as fruit trees.[10] Some cacti in the desert southwest have experienced no or reduced reproduction with overall population declines beginning in the 1990s. It is not clear if climate change is the driving factor in these declines, but increased temperatures and reduced precipitation could certainly be contributing to impacts on species like the endangered Acuna cactus.[11]

Droughts already affect estuarine ecosystems along the U.S.-Mexico border, such as the Tijuana River Estuary in California and the Rio Grande and Lower Laguna Madre of South Texas, which depend on adequate water flow for normal habitat function and biological productivity in and during extended droughts. Conflict among water users could reduce water allocated to ecosystems and conflicts among users for limited water resources could increase existing severe drought stresses. Climate projections for 2050 indicate that 32 percent of counties in the U.S. could be at high or extreme risk of water shortages (compared to 10% today), with the

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[5] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 345.

[6] "Lower Rio Grande Basin Study Shows Shortfall in Future Water Supply," U.S. Bureau of Reclamation, last modified December 17, 2013, [HYPERLINK "http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=45486"].

[7] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[8] E. R. Cook, R. Seager, R. R. Heim, R. S. Vose, C. Herweijer, and C. Woodhouse, "Megadroughts in North America: Placing IPCC Projections of Hydroclimatic Change in a Long-Term Palaeoclimate Context," *Journal of Quaternary Science* 25 (2010): 48–61, doi:10.1002/jqs.1303.

[9] M. P. Hoerling, M. Dettinger, K. Wolter, J. Lukas, J. Eischeid, R. Nemani, B. Liebmann, and K. E. Kunkel, "Present Weather and Climate: Evolving Conditions," Chap. 5 in *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, ed. G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy (Washington, D.C.: Island Press, 2013), 74–97.

[10] G. Garfin, G. Franco, H. Blanco, A. Comrie, P. Gonzalez, T. Piechota, R. Smyth, and R. Waskom, "Southwest," Chap. 20 in *Climate Change Impacts in the United States: The Third National Climate Assessment*, ed. J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe (Washington, D.C.: U.S. Global Change Research Program, 2014), 462–486, doi:10.7930/J08G8HMN.

[11] U.S. Fish and Wildlife Service. 2010. Rising to the Urgent Challenge. Strategic Plan for Repsonding to Accelerating Climate Change. 34 pages.

greatest concentration of extreme conditions occurring all along the U.S.-Mexico border.[12] Reduced stream flows and snowpack will affect tourism and recreation in the Southwest's rivers and lakes. A recent detailed study of the Colorado Basin, which supplies critical amounts of water to the border regions of California, Arizona, Baja California and parts of Sonora, concludes that by 2060, there will be an annual shortfall between water production and water demand ranging between 0 and 6.8 million acre feet with a median of 3.2 million acre-feet, leading to the curtailment of water deliveries to all users of the river's waters.[13] [14]

As air temperature increases so will the temperature of streams and rivers. Some species such as the Gila and Apache Trout and the Rio Grande Cutthroat Trout are dependent on cold water. Increases in stream temperature will affect oxygen levels, food resources and the ability of these native cold water species to compete with nonnative fishes.[15] The border region of southeast Arizona including the Santa Cruz, Gila, and San Pedro Rivers and the Rio Yacqui and Rio Concepcion are habitat for 16 of the 21 species of fish native to the region. There are also three native frogs, a salamander and several species of garter snakes dependent upon aquatic habitat in these drainages. Although current modeling cannot reliably project specific changes several decades in advance, modeling generally predicts warmer temperatures with more variable precipitation. Such changes will likely result in greater stress for species in the coming decades.[16]

The border region contains over 6,500 plant and animal species, including 148 species listed as endangered in the U.S.[17] About a dozen transboundary rivers provide water to cities, tribes, and farms in the two countries, including two major rivers, the Colorado River and the Rio Grande, and many smaller sources—such as the Tijuana and New rivers in California and Baja California, the Santa Cruz and San Pedro rivers in southern Arizona and northern Sonora, the Hueco Bolsón and the Mesilla-Conejo-Medanos in the Paso del Norte region, and the Mimbres-Los Muertos aquifer and drainage system in New Mexico. Major desert ecosystems include the Mojave (Imperial Valley, California), Sonoran (southern Arizona and Sonora), and Chihuahuan (eastern

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[12] S. B. Roy, L. Chen, E. H. Girvetz, E. P. Maurer, W. B. Mills, and T. M. Grieb, "Projecting Water Withdrawal and Supply for Future Decades in the U.S. under Climate Change Scenarios," *Environmental Science & Technology* 46 (2012): 2545–2556, doi:10.1021/es2030774.

[13] "Colorado River Basin Water Supply and Demand Study," U.S. Bureau of Reclamation, last modified July 31, 2015, [HYPERLINK "http://www.usbr.gov/lc/region/programs/crbstudy.html"].

[14] Bureau of Reclamation. 2016. SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water. Prepared for the United States Congress. Denver, CO: Bureau of Reclamation, Policy and Administration.

[15] U.S. Fish and Wildlife Service. 2010. Rising to the Urgent Challenge. Strategic Plan for Repsonding to Accelerating Climate Change. 34 pages.

[16] Duncan, Doug and Greg Garfin. 2006. Native Fish Conservation and Climate Variability in Southeastern Arizona. Borders, Boundaries and Time Scales. Proceedings of the Sixth Conference on Research and Resource Management in the Southwestern Deserts.

[17] U.S. Environmental Protection Agency, 2011. *State of the Border Region Indicators Report 2010.* Border 2012 U.S.-Mexico Environmental Program, p. 15. Accessed at: https://www.epa.gov/sites/production/files/documents/border-2012_indicator-rpt_eng.pdf

Arizona and western New Mexico) Deserts. Coastal zones at the eastern and western ends of the border contain important marine and freshwater habitat.[18] [19]

Coupled with non-climatic factors such as population growth and development pressure, the higher temperatures, more extensive and severe droughts and decreases in precipitation create challenges for protected natural areas, birds and wildlife, and riparian systems.[20] For example, in recent years demand has exceeded supply of water from the trans-border Colorado River system that serves 35 million people, irrigates three million acres in the U.S., and supplies 1.5 million acre-feet of water to Mexico by treaty.[21] The health of wetland ecosystems which are bountiful sources of biodiversity are impacted by these increasing pressures.[22] The border fence marking the international boundary between the two countries fragments wildlife habitats and may impact species' ability to access food and mates on the other side of the fence.[23]

Almost all border climate and environmental issues are binational, as most of the U.S. border population lives in sister cities separated from adjacent Mexican urban areas only by the international boundary, forming more than a dozen transboundary metropolitan regions. These range in size from the greater San Diego-Tijuana area, with 5 million people, to the area of Naco, Arizona-Naco, Sonora, with just over 6,000 people.[24] Each sister-city pair shares an ecosystem with common environmental issues, such as air and water pollution. All of these communities, even wealthier San Diego, are characterized by large numbers of poor residents vulnerable to climate effects.

In terms of human health, including needs for food and water security, expected temperature changes may understate the likely consequences of climate vulnerability along the border due to a projected increase in the number of extreme heat days and high nighttime temperatures, and reduced agricultural productivity. In the summer of 2011, for example, large areas of the inland U.S.-Mexico border region set records for the highest number of days with temperatures exceeding 100°F in recorded history. In some areas, there were more than 100 days when

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[18] Good Neighbor Environment Board (GNEB). 2006. *Air quality and transportation and cultural and natural resources on the U.S.-Mexico border: Ninth report of the GNEB to the President and Congress of the U.S.* EPA 130-R-06-002. Washington, DC: EPA.

[19] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[20] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[21] Udall, B. 2013. "Water: Impacts, Risks, and Adaptation." In *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 197–217. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

[22] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[23] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[24] Ganster and Lorey, *The U.S.-Mexican Border Today*, 140, Table 6.2.

temperatures exceeded 100°F. [25] During the 2011 heat event, rates of water loss due in part to evaporation were double the long-term average. Depleted water resources contributed to more than $10 billion in direct losses to agriculture alone.[26] In January 2012, customers of 1,010 Texas water systems were asked to restrict water use, while mandatory water limits were in place in 647 water systems.[27] In April 2015, California's governor ordered mandatory water use reductions of 25 percent annually by 400 local water supply agencies.[28]

The challenges of responding to the consequences of regional climate change are exacerbated by the socio-economic conditions of communities along the border region. With the exception of the City of San Diego, U.S. residents along the border have fewer financial resources than residents of other U.S. regions; three of the poorest ten counties in the U.S. can be found within 100 miles of the Mexico border,[29] and in 2013, nearly 30 percent of the U.S. population residing in 23 counties along the border was below the poverty level.[30] The cultures and languages are more diverse along the border than many areas elsewhere in the nation, as approximately half of all people residing in U.S. counties along the border speak Spanish as a first language.[31] [32] Federally recognized tribes and tribal communities along the border face the loss of traditional foods and medicines, culturally important animal species, and plant resources.[33] Historic land settlement patterns and high rates of poverty—more than double

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[25] Wilder et al., "Climate Change and U.S.-Mexico Border Communities," 340–384.

[26] M. Shafer, D. Ojima, J. M. Antle, D. Kluck, R. A. McPherson, S. Petersen, B. Scanlon, and K. Sherman, "Great Plains," Chap. 19 in *Climate Change Impacts in the United States: The Third National Climate Assessment*, ed. J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe (Washington, D.C.: U.S. Global Change Research Program, 2014), 441–461. doi:10.7930/J0D798BC.

[27] K. Wythe, "Community Water Systems Recovering from the Drought: Lessons Learned; Plans Made," *tx H_2O* 7, no.2 (2012): 6–9, [HYPERLINK "http://twri.tamu.edu/publications/txh2o/summer-2012/community-water-systems/"].

[28] Calif. Exec. Order No. B-29-15 (Apr. 1, 2015), [HYPERLINK "https://www.gov.ca.gov/docs/4.1.15_Executive_Order.pdf"]

[29] "Border Region," United States-México Border Health Commission, accessed December 9, 2015, [HYPERLINK "http://www.borderhealth.org/border_region.php"].

[30] "Small Area Income and Poverty Estimates: 2013 All Ages in Poverty," U.S. Census Bureau, last modified September 16, 2015, [HYPERLINK "http://www.census.gov/did/www/saipe/data/interactive/saipe.html"].

[31] Good Neighbor Environmental Board, "*A Blueprint for Action on the U.S.-Mexico Border, 13th Report of the Good Neighbor Environmental Board to the President and Congress of the United States, EPA 130-R-10-001* (Washington, D.C.: U.S. Environmental Protection Agency, 2010), 4, [HYPERLINK "http://www.epa.gov/sites/production/files/documents/eng_gneb_13th_report_final.pdf"].

[32] P. Ganster with D. E. Lorey, *The U.S.-Mexican Border Today: Conflict and Cooperation in Historical Perspective* (Lanham, MD: Rowman & Littlefield, 2015), 152.

[33] K. Cozzetto, K. Chief, K. Dittmer, M. Brubaker, R. Gough, K. Souza, F. Ettawageshik, S. Wotkyns, S. Opitz-Stapleton, S. Duren, and P. Chavan, "Climate Change Impacts on the Water Resources of American Indians and Alaska Natives in the U.S." *Climatic Change* 120 (2013): 569–584, doi:10.1007/s10584-013-0852-y.

that of the general U.S. population,[34] complicate tribes' and other disadvantaged populations' abilities to respond to the challenge of a changing climate.

The region, however, is critical for the prosperity of the U.S. economy. Mexico is the second largest trading partner of the U.S. By 2014, U.S.-Mexico trade was nearly $500 billion, and most of that trade moved through the land ports of entry along the southern border in truck and rail containers.[35] [36] Some border regions are areas of especially significant economic activity, such as the biotechnology cluster in San Diego; aerospace in Arizona; petroleum and natural gas in Texas; and intensive irrigated agriculture—especially fresh fruits and vegetables—in Imperial County, California, adjacent areas in Arizona, and in Texas' lower Rio Grande Valley.

Although the benefits of U.S.-Mexico trade are spread widely throughout the Nation, many of the costs associated with the flow of goods are borne by border communities in the form of a saturated transportation infrastructure, heavy truck traffic through communities, and air pollution caused by traffic and exacerbated by excessive waiting times for northbound crossings at the border.[37] Although transnational trade creates jobs in both the U.S. and Mexico border regions in transportation and warehousing, these tend to pay low wages without benefits and so fail to address the border-wide issue of low per capita income.[38]

Low-income rural and urban residents of border communities, especially communities of color, are more vulnerable to climate risks.[39] The U.S.-Mexico Border Health Coalition (2013) identified eight highly-vulnerable border populations in terms of health impacts from climate, including low-income and indigents, homeless, uninsured and underinsured, limited and non-English speakers, elderly, migrant laborers and farmers, newer immigrants, and undocumented

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[34] M. Sarche and P. Spicer, "Poverty and Health Disparities for American Indian and Alaska Native Children," *Annals of the New York Academy of Sciences* 1136 (2008): 126–136, doi:10.1196/annals.1425.017.

[35] "Mexico," Office of the U.S. Trade Representative, last modified May 1, 2014, [HYPERLINK "https://ustr.gov/countries-regions/americas/mexico"].

[36] "Trade in Goods with Mexico," U.S. Census Bureau, accessed December 9, 2015, [HYPERLINK "https://www.census.gov/foreign-trade/balance/c2010.html"].

[37] E. Lee and C. E. Wilson, *The State of Trade, Competitiveness and Economic Well-being in the U.S.-Mexico Border Region* (Washington, D.C.: Wilson Center, 2012), [HYPERLINK "https://www.wilsoncenter.org/sites/default/files/State_of_Border_Trade_Economy_0.pdf"].

[38] Ganster and Lorey, *The U.S.-Mexican Border Today*, 232.

[39] Shonkoff, S.B., et al., 2011. The climate gap: environmental health and equity implications of climate change and mitigation policies in California. Climatic Change, 109 (Suppl. 1), S485–S503.; USGCRP, 2016: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. [HYPERLINK "http://dx.doi.org/10.7930/J0R49NQX"]

immigrants.[40] Poorer residents of U.S. border communities most often live in substandard housing that is more vulnerable to climate extremes. Poor residents may not be able to afford air conditioning, and their homes may be located in areas more prone to flooding or adjacent to major transportation routes and ports of entry that have poor air quality.[41] For example, studies have shown that within El Paso, Texas, children in economically distressed families faced disproportionate exposure to peak ozone events.[42] With reduced access to medical care relative to the general population, disadvantaged communities along the border experience a greater burden from climate change.

Increases in heat-related illness and death are linked to heat exposure. The primary cause of weather-related deaths in the U.S. is heat and excessive heat leads to high morbidity, particularly for low-income and minority populations. For example, the Arizona Department of Health Services documented 1,535 deaths due to heat between 2000 and 2012. Half of the deaths were of undocumented migrants who died while crossing the desert during the summer months. Of the nearly 586 Arizona residents who died due to heat-related causes, more than half were Hispanic persons, half were over the age of 57, and many died within their homes.[43]

Climate change may affect mosquito-borne disease vectors in the border region, including transmission of West Nile virus.[44] Valley fever, plague, and Hanta pulmonary syndrome are also linked to climate change in the U.S. southwest, though the direction and impacts of the changes are specific to diseases and locations.[45] Climate change is expected to increase particulate matter stemming from wildfires with implications for respiratory health, particularly for the elderly, children and infants, and those with pre-existing cardiovascular conditions.[46]

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[40] U.S.-Mexico Border Health Commission. (2013). *Prevention and Health Promotion Among Vulnerable Populations on the U.S.-Mexico Border—Synthesis Report*. XX: New Mexico Department of Health, October 31, 2013.

[41] P. J. E. Quintana, P. Ganster, P. E. Stigler Granados, G. Muñoz-Meléndez, M. Quintero-Núñez, and J. G. Rodríguez-Ventura, "Risky Borders: Traffic Pollution and Health Effects at US–Mexican Ports of Entry," *Journal of Borderlands Studies* (2015): 1–21, doi:10.1080/08865655.2015.1066697.

[42] S. Grineski, T. Collins, P. Ford, R. Fitzgerald, R. Aldouri, G. V. Velázquez-Angulo, M. Aguilar, and D. Lu, "Climate Change and Environmental Injustice in a Bi-National Context," *Applied Geography* 33 (2012): 25–35, doi:10.1016/j.apgeog.2011.05.013.

[43] Arizona Department of Health Services (ADHS), 2012. Trends in morbidity and mortality from exposure to excessive natural heat in Arizona. Phoenix: Arizona Department of Health Services.

[44] Brown, H. E., A. C. Comrie, D. M. Drechsler, C. M. Barker, R. Basu, T. Brown, A. Gershunov, A. M. Kilpatrick, W. K. Reisen, and D. M. Ruddell. 2013. "Human Health." In *Assess- ment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assess- ment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 312–339. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

[45] Brown, H. E., A. C. Comrie, D. M. Drechsler, C. M. Barker, R. Basu, T. Brown, A. Gershunov, A. M. Kilpatrick, W. K. Reisen, and D. M. Ruddell. 2013. "Human Health." In *Assess- ment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assess- ment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 312–339. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

[46] Brown, H. E., A. C. Comrie, D. M. Drechsler, C. M. Barker, R. Basu, T. Brown, A. Gershunov, A. M. Kilpatrick, W. K. Reisen, and D. M. Ruddell. 2013. "Human Health." In *Assess- ment of Climate Change in the Southwest United*

The trend toward longer, hotter, and drier summer seasons is likely one factor contributing to the significant increase in large wild fires in the western United States and those burning across the international U.S.-Mexico boundary.[47] [48] Increased warming and drought will further stress forest areas and result in insect infestations. The accumulation of woody fuel and the spread of non-native grasses have contributed to making the region more vulnerable to intense wildfires.[49] Increased temperatures will also contribute to a longer fire season. Fire models project more wildfires and increased risks to communities across extensive border areas.[50] Drought changes vegetation, affects grazing potential, reduces crop productivity, compromises water quality and availability, and increases the amount of power required for water pumping and purification.[51] Higher temperatures increase crop water requirements and air conditioning electrical demands for industry, business, and residential needs. Projected warming may reduce chilling periods and induce changes in the seasonal timing of crop development.

Rising sea levels along both the Gulf of Mexico and Pacific coasts will increase the chances of floods and damage water quality and ecosystem health. Based on tide gauge data, the past 100-year trend for sea level rise is 0.68 feet near San Diego, California, and 1.24 feet near Port Isabel, Texas.[52] Intermediate-low projections of the increase in local relative sea level from

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States: A Report Prepared for the National Climate Assess- ment, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 312–339. A report by the Southwest Climate Alliance. Washington, DC: Island Press.

[47] Joyce, L. A., S. W. Running, D.D. Breshears, V.H. Dale, R.W. Malmsheimer, R.N. Sampson, B. Sohngen, and C.W. Wood et al. 2014. Third National Climate Assessment. 2014. Chapter 7, Forests. U.S. Global Change Research Program, 175-194.

[48] Westerling, A.L., H.G. Hidalgo, D.R. Cayan, T.W. Swetnam. 2006. Increases in Western US Forest Wildfire Associated with Warming and Advances in the Timing of Springy, Science Express 313, 940.

[49] E. Fleishman, J. Belnap, N. Cobb, C. A. F. Enquist, K. Ford, G. MacDonald, M. Pellant, T. Schoennagel, L. M. Schmit, M. Schwartz, S. van Drunick, A. L. Westerling, A. Keyser, and R. Lucas, "Natural Ecosystems," in *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, ed. G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy (Washington, D.C.: Island Press, 2013), 148–167.

[50] Garfin et al., "Southwest," 462–486.

[51] K. Hibbard, T. Wilson, K. Averyt, R. Harriss, R. Newmark, S. Rose, E. Shevliakova, and V. Tidwell, "Energy, Water, and Land Use," Chap. 10 in *Climate Change Impacts in the United States: The Third National Climate Assessment*, ed. J. M. Melillo, Terese (T. C.) Richmond, and G. W. Yohe (Washington, D.C.: U.S. Global Change Research Program, 2014), 257-281, doi:10.7930/J0JW8BSF.

[52] "Sea Level Trends," National Oceanic and Atmospheric Administration, last modified October 15, 2013, [HYPERLINK "http://tidesandcurrents.noaa.gov/sltrends/sltrends.html" \t "_blank"]. 2013 update of National Oceanic and Atmospheric Administration, *Sea Level Variations of the United States 1854–2006, Technical Report NOS CO-OPS 53* (Silver Spring, MD: National Oceanic and Atmospheric Administration, 2009), https://tidesandcurrents.noaa.gov/publications/Tech_rpt_53.pdf.

2015 to 2050 for these two locations (taking into account only ocean thermal expansion but not melting ice) suggest an additional 0.49 feet and 0.70 feet, respectively.[53] [54]

With elevated sea levels, the potential for coastal flooding—as well as erosion of bluffs, beaches, and barrier islands—increases. The risk of damage and recurrent shallow coastal flooding from higher daily tides, as well as storm surge and destructive wave action from tropical storm events will increase. Texas' Gulf Coast averages approximately three tropical storms or hurricanes every 4 years,[55] generating coastal storm surge and sometimes bringing heavy rainfall and damaging winds hundreds of miles inland. Sea level rise creates the potential for greater damage from storm surge along both the Texas and California coasts. Coastal estuaries and marsh complexes may become inundated as sea level rises. Saltwater intrusion into coastal aquifers can damage potable water sources. Episodic and chronic coastal flooding could put at risk critical coastal infrastructure in San Diego and Texas, including ports, roads, bridges, and energy production and sewage treatment facilities, as well as urban beachfront development. Shorter term climate fluctuations, such as those caused by El Niño, can further stress the productivity, integrity, and rebound capacity of economic, social, and environmental systems.

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[53] USACE Sea Level Calculator (version 2015.46; accessed December 9, 2015), [HYPERLINK "http://www.corpsclimate.us/ccaceslcurves.cfm" \t "_blank"]. Based on regionally corrected rates from National Oceanic and Atmospheric Administration, *Estimating Vertical Land Motion from Long-Term Tide Gauge Records, Technical Report NOS CO-OPS 065* (Silver Spring, MD: National Oceanic and Atmospheric Administration, 2013), [HYPERLINK "http://tidesandcurrents.noaa.gov/publications/Technical_Report_NOS_CO-OPS_065.pdf" \t "_blank"].

[54] NOAA scenarios based on A. Parris, P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss, *Global Sea Level Rise Scenarios for the United States National Climate Assessment, Technical Report OAR CPO-1* (Washington, D.C.: National Oceanic and Atmospheric Administration, Climate Program Office, 2012), [HYPERLINK "http://cpo.noaa.gov/sites/cpo/Reports/2012/NOAA_SLR_r3.pdf" \t "_blank"].

[55] D. Roth., *Texas Hurricane History* (Camp Springs, MD: National Weather Service, 2010), [HYPERLINK "http://www.srh.noaa.gov/images/lch/tropical/txhurricanehistory.pdf"].

Chapter Two: Existing Federal Programs and Resources

The U.S. Federal government is committed to investing significant financial and human resources in the border region to address water, air quality, energy and health issues, as well as the movement of goods and people. Collectively, federal and binational agencies have many years of experience in working across the international boundary; local and state actors also participate in transboundary activities, sometimes convened by federal agencies. The Border Liaison Mechanism also enables local U.S. and Mexican consuls to organize U.S. and Mexican government agencies and other stakeholders to interface directly on transboundary issues. Regular transboundary consultation can empower cooperative local responses and enhance border resiliency.

Ongoing programs can be focused to address binational challenges and climate change vulnerabilities in the U.S.-Mexico border region. Through careful planning, bilateral collaboration with local and international partners and research, federal agencies are taking actions to reduce pollution and environmental degradation along the border, and address climate change.

Agency/Organization Summary

a. Mission, organization or agreement & how it relates to climate change along the border

US Department of Health and Human Services

Under the Department of Health and Human Services (DHHS), the Border Health Commission (BHC) provides international leadership to optimize health and quality of life along the U.S.-México border through health promotion and disease prevention by convening stakeholders from various sectors. In regards to environmental health, the BHC has established a collaborative partnership with the Environmental Protection Agency (EPA) to coordinate activities that support the BHC's *Healthy Border 2020* initiative and EPA's *Border 2020* program.

US Department of Agriculture/Natural Resources Conservation Service

The U.S.-Mexico border runs an estimated 1,933 miles from California to Texas. Within this vast landscape lies a variety of ecosystems, critical habitats, and treasured landscapes ranging from deserts and mountains, to natural waterways, such as rivers, streams and creeks. The Natural Resources Conservation Service (NRCS), a non-regulatory agency under the United States Department of Agriculture (USDA), works with private landowners and land managers to plan and implement conservation efforts with a wealth of environmental and social benefits, including clean water and air, healthy wildlife habitat, open space, food and fiber, and sustainable rural and urban communities. The agency works with landowners, farmers, ranchers and Tribal members in the border region to aid with conservation practices and technical and financial assistance in an effort to protect, restore and enhance impaired natural ecosystems. Natural ecosystems in this border region face challenges, such as extreme weather, land fragmentation and urban encroachment. With the mission of "Helping People, Help the Land," NRCS provides on-the-ground conservation assistance through its guiding principles - service, partnership and technical excellence. In turn, the region experiences measurable and sustainable ecosystem restoration, such as improved water quality and quantity, air quality, productive soils, healthy plant

communities and thriving wildlife communities.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration's (NOAA) science and stewardship programs advance the understanding of and ability to anticipate changes in the environment, improve society's ability to make scientifically informed decisions, and conserve and manage ocean and coastal resources. As it relates to climate change mitigation and resiliency, NOAA's observations, tools, and information help people understand and prepare for climate variability and change.

Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) is the United States lead agency on the protection of human health and the environment. The EPA is also responsible for implementing Emergency Support Function 10, Oil and Hazardous Materials Response, during declared disasters or emergencies that can include major storms and other climate related incidents.

Addressing the environmental issues along the border has long been a priority that EPA strives to address, along with sister environmental agencies in Mexico. There is a shared concern of environmental degradation, pollution and the diseases triggered across national boundaries.

The EPA-led binational Border 2020 Program was implemented under the 1983 La Paz Agreement, which empowers federal environmental authorities in the US and Mexico to undertake cooperative initiatives, implemented through multi-year binational programs. In collaboration with Mexico's SEMARNAT, and with help from EPA's partners in state government, industry, academia and local communities, the Border 2020 Program builds upon the significant progress already made on climate change and other environmental issues under Border 2012 Program. Border 2020 also strengthens emphasis on regional, bottom-up approaches for decision-making, priority setting and project implementation to protect and improve the environment and public health along the border, and focuses where environmental improvements are needed most: establishing thematic goals, supporting the implementation of projects, considering new fundamental strategies, and encouraging the achievement of more ambitious environmental and public health goals.

Department of State and the U.S. Agency for International Development (USAID)

The Department of State and USAID support national and subnational policy development to advance Mexican-led climate change initiatives, including its 2012 General Law on Climate Change, and implementation of its energy reform. These efforts are anchored by a focus on switching to cleaner energy sources and increasing energy efficiency. The initiatives are not directed at the border-region specifically, but impact the border as they are implemented country wide. As the U.S. communities on the border are intrinsically tied to their often much larger Mexican counterpart, changes in Mexico have a direct impact on the United States.

Department of Homeland Security

Department of Interior

Other State Agency's Efforts

Pending submissions

b. Examples of efforts to mitigate climate change or develop resiliency (e.g. agencies with oversight of programs impacting the border region)

DHHS

In 2015, the BHC, together with EPA Regions 6 and 9, implemented environmental health trainings for health promoters (promotores) in cities throughout the border region (Figures 1 and 2), covering topics such as air quality, carbon monoxide, asthma, lead exposure, pesticides, household chemicals, water quality and drought within the Texas-Chihuahua region. In regards to climate change, participants addressed what measures their communities and organizations are currently taking and how to implement additional measures, exchanging resources. These capacity-building trainings were achieved in coordination with many other governmental and non-governmental organizations.

Figure 1: Pema Garcia, Texas A&M

Figure 2:

The BHC and EPA also collaborated to implement two Children's Health Symposia in 2015 and 2016 in El Paso, Texas, and San Diego, California. Both included discussions on climate change and its effects on children's health, especially with regard to infectious diseases, respiratory illness, and heat-related illnesses.[1] Based on the positive feedback from these two symposia, the BHC and EPA are planning a third symposium in August 2016 in Brownsville, Texas.

The BHC's *Healthy Border 2010* initiative, modeled after the DHHS *Healthy People 2010* initiative and México's *National Health Indicators,* included respiratory diseases as a focus area. The U.S. objective was to reduce the hospitalization rate by 40% and México's objective was to stabilize the asthma hospitalization rate. State and national hospital data were used to measure these objectives. However, at the end of the decade, the U.S. objective was not met, while the México objective was making progress. In the U.S. Border States, adult asthma hospitalization rates actually increased from 2000-2010, with the largest increase in Arizona from a rate of 84.4 per 100,000 in 2000 to 105.6 per 100,000 in 2009.

In HB2020, asthma is identified as a priority health issue with the adjoining objective to reduce asthma-related hospitalization rates by 25%. Strategies include improving air quality in binational air sheds and reducing asthma triggers in homes, schools, and childcare centers.

USDA/NRCS

NRCS has the opportunity to mitigate climate change through conservation practices that help reduce greenhouse gas emissions by increasing carbon sequestration in soils and perennial biomass. Under the USDA's Climate Change Building Blocks strategy, NRCS is increasing focus on working with producers through voluntary and incentive-based financial and technical assistance programs. The climate change strategy includes opportunities to leverage efforts with industry, farm groups, conservation organizations, municipalities, tribes, and states. Additionally, the Climate Smart Agriculture and Forestry Building Blocks are a Department-wide framework of mitigation opportunities for agriculture and forestry.

NRCS is working on six climate mitigation building blocks in FY2016, including soil health, nitrogen management, livestock partnership, grazing and pasture, energy efficiency, and private forests. In Texas, two climate change mitigation opportunities are being offered along the border. The Rio Grande Project near Fort Quitman promotes carbon sequestration in soil, promoting a balance in the hydrologic cycle on both rangeland and cropland. The second project along the Southern Texas Rio Grande River focuses on soil health and grazing on pasturelands to increase carbon sequestration.

Successfully addressing ecosystem resource concerns through efficient and effective programs and conservation practices are key to achieving sustainable restoration efforts. These resource concerns include water quality and quantity, fish and wildlife habitats, plant health, soil erosion, endangered species and invasive species. NRCS also works closely with the Texas State Soil and Water Conservation Board in promoting conservation practices.

The South Texas border region is essential migratory habitat for a number of insect, bird and animal species. The Monarch butterfly and neotropical bird populations depend on this area's ecosystems for suitable and abundant habitat along their migration journey. The Migratory and

Shore Bird Habitat Initiative (MSBHI), initiated in FY13 is ongoing and focuses conservation planning efforts on migrating, shorebird, and grassland nesting bird habitats. NRCS implemented a Statewide Resource Concern to include the southernmost border counties in this special funding area. Brush management, grass planting, prescribed burning and prescribed grazing are being planned and implemented on acreages to emulate open prairie and savannah type ecosystems that are dependent areas for grassland bird species.

Efforts targeting invasive species, such as Tamarisk (salt cedar), giant cane and desert willow, are on-going. These three plants occur in varying abundance along the Rio Grande River and present environmental and cultural challenges, as these species are generally viewed as invasive by the land owners, operators and managers, but not necessarily by Native American Tribes.

In FY15, Texas, New Mexico and Arizona were three of 21 states, including Puerto Rico that participated in the USDA's national StrikeForce for Rural Growth and Opportunity initiative, designed to provide relief in counties of persistent poverty, 85% of which are in rural areas. NRCS collaborated closely with USDA agencies, partners, community-based organizations, stakeholders and communities in an effort to increase USDA outreach to underserved populations and rural communities, while also improving access to and participation in USDA programs. This initiative strives to provide additional economic opportunities and benefits to these areas. As a result, farmers, ranchers and private landowners are operating more sustainably while their conservation practices promote clean air and water, healthy soil, wildlife habitat and resistance to extreme weather events, such as drought. Texas alone, provided $1.2 million through the agency's EQIP program to farmers and ranchers in StrikeForce counties.

USAID

USAID supports Mexican efforts to remain committed to a low-carbon future through the reduction of greenhouse gas emissions from the energy and forestry, land-use and land-use change sectors. Further, USAID supports Mexico's efforts to establish internationally robust systems for monitoring, reporting and verifying emission rates and reductions, strengthening policies and institutional and technical capacities, and creating a sustainable source of financial support for programs that help mitigate climate change.

Key Achievements

- USAID provided technical assistance for the development of Mexico's Climate Change Strategy.
- Assisted Mexico to formulate mitigation cost curves for GHG abatement strategies.
- Assisted development of a model for social and environmental safeguards for Reducing Emissions from Deforestation and Degradation.
- Developed an overall planning roadmap for integrating renewable energy into Mexico's electrical grid.
- Fostering peer-to-peer learning, training, and exchanges of technical experts in climate change and energy, leading to multiple outcomes, including the design of a clean energy certificate system – the key incentive for renewable power generation.

NOAA

Climate.gov

NOAA Climate.gov provides science and information for a climate-smart nation. Americans' health, security, and economic well-being are closely linked to climate and weather. People want and need information to help them make decisions on how to manage climate-related risks and opportunities they face. NOAA Climate.gov is a source of timely and authoritative scientific data and information about climate. Our goals are to promote public understanding of climate science and climate-related events, to make our data products and services easy to access and use, to provide climate-related support to the private sector and the Nation's economy, and to serve people making climate-related decisions with tools and resources that help them answer specific questions.

Relevant Case Study for Highlight Table:

- [HYPERLINK "https://www.climate.gov/news-features/features/drought-rio-grande"]

Climate Resilience Toolkit

NOAA's U.S. Climate Resilience Toolkit provides scientific tools, information and expertise to help people manage their climate-related risks and opportunities, and improve resilience to extreme events. The web site is designed to serve interested citizens, communities, businesses, resource managers, planners, and policy leaders at all levels of government.

Using plain language, the Climate Resilience Toolkit helps people face climate problems and find climate opportunities. The site offers:

- Steps to Resilience—a five-step process you can follow to initiate, plan, and implement projects to become more resilient to climate-related hazards.
- Taking Action stories—real-world case studies describing climate-related risks and opportunities that communities and businesses face, steps they're taking to plan and respond, and tools and techniques they're using to improve resilience.
- A catalog of freely available Tools for accessing and analyzing climate data, generating visualizations, exploring climate projections, estimating hazards, and engaging stakeholders in resilience-building efforts.
- Climate Explorer—a visualization tool that offers maps of climate stressors and impacts as well as interactive graphs showing daily observations and long-term averages from thousands of weather stations.
- Topic narratives that explain how climate variability and change can impact particular regions of the country and sectors of society.
- Pointers to free, federally developed training courses that can build skills for using climate tools and data.
- Maps highlighting the locations of centers where federal and state agencies can provide regional climate information.
- The ability to Search the entire federal government's climate science domain and filter results according to your interests.

Relevant Case Study for Highlight Table:

- [HYPERLINK "http://toolkit.climate.gov/taking-action/boosting-ecosystem-resilience-southwests-sky-islands"]

National Integrated Drought Information System (NIDIS)

NOAA's National Integrated Drought Information System (NIDIS) program was authorized by Congress in 2006 ([HYPERLINK "https://www.drought.gov/drought/sites/drought.gov.drought/files/media/whatisnidis/Documents/PLAW-109publ430.pdf" \t "_blank"]) with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system. NIDIS' goal is to improve the nation's capacity to manage drought-related risks by providing the best available information and tools to assess the potential impacts of drought, and to prepare for and mitigate the effects of drought. Toward that end, NIDIS seeks to create a Drought Early Warning System (DEWS) for the nation.

A DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

[HYPERLINK "https://www.drought.gov/nadm/"]

The North America Drought Monitor (NADM) is a cooperative effort between drought experts in Canada, Mexico and the United States to monitor drought across the continent on an ongoing basis. The NADM is based on the highly successful U.S. Drought Monitor (USDM), and as such, is being developed to provide an ongoing comprehensive and integrated assessment of drought throughout all three countries.

Each country has active climate and drought monitoring programs and this program supports cooperation and coordination between the countries' drought experts. Past drought assessments typically have stopped at each country's borders as differences in resources and policy objectives as well as differing methods for monitoring drought in each country effectively prevented an integrated view of drought conditions across the continent. The NADM program is designed to overcome these past limitations by providing monthly assessments of drought across the continent.

NOAA Digital Coast

The Digital Coast provides coastal data, tools, and training to coastal managers in order to help communities address climate resiliency issues and other topics. Data sets include economic data, satellite and LiDAR imagery, hydrography datasets, land cover databases, and bathymetry, among numerous other datasets. The Digital Coast is maintained by NOAA's Office for Coastal Management but hundreds of organizations including federal, state and local agencies have contributed content.

Assessing Fire Hazard Risk in Southern California - Southern California is at great risk from wildfires because of its particular combination of weather, topography, and native vegetation, as well as the Santa Ana winds that appear in the spring and late fall. While

wildfires are inevitable in this region, over the past few decades the fire risks—including the loss of life and property—have increased with enduring drought conditions and the encroachment of developments into fire-prone lands. To analyze areas at risk from wildfire and their proximity to urban developments, as well as changes to these risks over time, the Global Ecosystem Center (GEC) used NOAA's Coastal Change Analysis Program (C-CAP) land cover data sets. C-CAP provides a nationally standardized source for accurate baseline information, and because all C-CAP data sets were created using the same criteria and standards, they can be compared against one another to document changes over multiple years. With these standardized data sets as a guide, GEC used additional archived Landsat imagery from 1984 and 2011 to evaluate the land cover over a longer time span. The analysis, spanning 26 years of data, demonstrates that the region between Los Angeles and San Diego experienced the highest rates of urban growth, and many of the new developments are in areas at significant risk of fire. This information is being used to develop better strategies for land use management, natural resource management, and vulnerability.

NOAA Regional Coastal Resilience Program

NOAA's Office for Coastal Management, part of the National Ocean Service, administers this program to help coastal communities prepare for and recover from extreme weather events, climate hazards, and changing ocean conditions. The focus is on comprehensive regional approaches that use science-based solutions and rely on collaborative partnerships to ensure success.

The San Diego Regional Climate Collaborative, a partnership of local and regional agencies and organizations, will lead a multifaceted project to protect the county's approximately 70 miles of coastline from vulnerabilities to sea level rise, coastal flooding, and extreme weather events. By filling key information gaps and providing additional legal, scientific, and economic analyses, the project will help the cities of Oceanside, Carlsbad, Encinitas, Solana Beach, Del Mar, San Diego, and Imperial Beach develop coordinated sea level rise vulnerability assessments and integrated coastal resilience strategies. These efforts will be paired with an innovative and consistent regional communication strategy that also expands public understanding and engagement in coastal resilience planning and actions. This comprehensive strategy will result in implementable actions that reduce the region's risks and vulnerabilities and build regional coastal resilience.

The Gulf of Mexico Alliance and partners will help ten Gulf of Mexico coastal communities enhance their overall resilience to future hazards through pilot projects using new and updated information and tools. The approach involves evaluating each community from a natural resource and human use perspective, and providing a small grant to implement cost-effective solutions to increase resilience. Project partners will also create a network to support additional regional coordination and collaboration for resilience efforts and sharing lessons learned.

Case Studies

[HYPERLINK "https://coast.noaa.gov/digitalcoast/stories/californiafire"] (**NOAA Digital Coast)**
San Diego Climate Collaborative (**NOAA Regional Coastal Resilience Program**)

Gulf of Mexico Alliance (**NOAA Regional Coastal Resilience Program**)
[HYPERLINK "https://www.climate.gov/news-features/climate-case-studies/built-last-climate-data-ensure-oil-supply-route-gulf-mexico"] (case study available via climate.gov)

[HYPERLINK "http://www.ioos.noaa.gov/ioos_in_action/stories/ocean_observing_mexico.html"] (news summary available via IOOS web site)

Environmental Protection Agency

Border 2020 establishes five environmental and public health goals coupled with specific objectives and strategic approaches for accomplishing each goal. The five goals are:

1- Reduce Air Pollution
2- Improve Access to Clean and Safe Water
3- Promote Materials Management, Waste Management, and Clean Sites
4- Enhance Joint preparedness for Environmental Response
5- Enhance Compliance Assurance and Environmental Stewardship

Within the five goals are specific objectives that identify priority areas and activities that program partners will undertake for the duration of the program. The Program strives to protect the environment and public health in the U.S.-Mexico border region through sustainable development, defined as "conservation-oriented social and economic development that emphasizes the protection and sustainable use of resources, while addressing both current and future needs, and present and future impacts of human actions." (USEPA Border 2020 Summary)

More detailed information for the Border 2020 goals and objectives can be found at https://www.epa.gov/border2020/goals-and-objectives or https://www.epa.gov/sites/production/files/documents/border2020summary.pdf

Children's Health

EPA is working with partners along the US/Mexico Border to address binational environmental challenges and disproportionate health impacts that burden border communities. Health impacts include poor indoor and outdoor air quality, mismanagement of pesticides, misuse of chemicals and other waste, poor water quality, and binational chemical emergencies.

First EPA Children's Health Symposium on the Border

EPA launched Children's Health Month on September 24-25, 2015, by co-hosting Children's

Environmental Health on the Border: Protecting Children Where They Live, Learn, and Play, the first bi-national symposium held on the campus of Texas Tech in El Paso, and hosted by the Southwest Center for Pediatric Environmental Health. Texas Tech is a new EPA partner and now home to the newest Pediatric Environmental Health Speciality Unit (PEHSU). The PEHSU is a network of physicians jointly funded by EPA and the Agency for Toxic substances and Disease Registry. The symposium utilized the PEHSU network to put on the training, and Texas Tech provided continuing education credits for attendees. About 150 doctors, nurses, promotoras, and public health professionals attended the two-day session, in which 30 experts presented on issues such as asthma, lead and mercury exposure, climate change impacts on children's health and a dozen other topics. Simultaneous English/Spanish translation was provided for all presentations.

Protecting kid's health is central to EPA's mission and the symposium was one of many CEH initiatives along the Border. Together with our partners at state agencies, universities, non-profits, and local municipalities, EPA has been working to specifically address children's health protection in border communities. The US/Mexico Border program has provided funding to assist a dozen organizations, with more than $500,000 over the past three years specifically for children's health. Funding has supported capacity-building through training for child care and school personnel, environmental home assessments, to educate farm workers about take-home pesticide exposures, and to train those who train others. Directly, these efforts have impacted about 25,000 people. However, when a promotora carries the message about children's health protection into a community, or physicians hear about children's health protection in grand rounds, on via on-line training, they may have long-term, multiplicative impacts within a community.

Protecting Farm Workers and Their Families

The Region 6 Pesticides Program continues to address safe work practices among farm workers, especially children. Region 6 provided support for the play, El Moscas y Los Pesticidas to be performed on May 27, and June 3, 2015. It was performed and hosted by Telon De Arena at the Chamizal National Memorial, an urban park located in El Paso, Texas. El Moscas y Los Pesticidas is a humorous and interactive play (in Spanish) developed by Region 6 in 2009 to help increase pesticide safety awareness for farm workers and prevent "take-home" risks to their families. At least three schools consisting of 4th, 5th and 6th grade students from El Paso TX and Las Cruces, NM attended the performance. Based on pre- and post-evaluation forms, approximately 1000 attendees' awareness on pesticides safety increased.

New Pesticides Rule Proposed: Reaching far beyond the US/Mexico Border area, EPA issued a proposal to revise the Certification of Pesticide Applicators rule on August 5, 2015. The proposed rule strengthens training and certification standards for pesticide applicators who are certified to apply the riskiest pesticides, known as restricted use pesticides (RUPs). Federal regulations require applicators to be certified in order to apply RUPs. Additionally, RUPs may be used only by, or under the direct supervision of, certified applicators. The proposed rule also establishes a first time-ever nation-wide minimum age of 18 for certified applicators and persons working under their direct supervision. The goal is to reduce the likelihood of harm from the misapplication of RUPs and ensure a consistent level of protection among states.[1]

Bi-national Emergency Response
The Goal 4 Task Forces regularly discuss, plan, prepare, and exercise for potential emergency responses due to the increased potential for floods, fire and severe storms as a result of climate change. EPA coordinates closely with FEMA, NOAA, the Coast Guard, other Federal agencies and State and local agencies (e.g., Proteccion Civil, County Emergency Managers, Department of Emergency Management) through both the Goal 4 task forces and the Regional Response Team.

State of California

Climate Change Program
The State of California has been a leader in reducing GHG emissions from energy production. The State has a Renewable Portfolio Standard goal that, by 2030, 50% of all electricity consumed in the state will be generated from renewables. In 2014, the State was at the half-way point. The State also has implemented programs to encourage the installation of photo-voltaic on residential and commercial properties and the purchase of electric vehicles.

Annual outreach campaign in Mexicali
Every Christmas season, the Imperial County Air Pollution Control District implements an outreach program, including airing commercials on local television in Mexicali to discourage the use of fireworks and open-burning, both of which are sources of NO_x and Particulate Matter impacting Imperial County.

Department of Homeland Security

Department of Interior

Texas Commission on Environmental Quality

Other State Agency's Efforts?

II. US-Mexico border region trans-boundary cooperation – describe the mission, implementation, outcomes/impacts and challenges

International Boundary and Water Commission
With antecedents dating back to the settlement of the Mexican-American war, the International Boundary and Water Commission (IBWC) is an international organization, with the U.S. and Mexico sharing joint responsibility for managing various boundary and water treaties between nations, and settling differences that arise. Commissioners appointed by the respective presidents head both Sections, which are administered and funded independently.

The IBWC's mission relates to climate change challenges principally in the execution of its

water distribution and flood control responsibilities. IBWC activities include transboundary water distribution in the Rio Grande and Colorado River watersheds, operation and maintenance of water storage reservoirs and hydroelectric dams on the Rio Grande, and flood protection along the principal boundary rivers through levee and interior floodway projects. The Commission's border sanitation and water quality mission includes the operation of wastewater treatment plants in San Diego, CA and Nogales, AZ, both the responsibility of US Section of IBWC, while the Mexican Section manages a wastewater treatment plant in Nuevo Laredo, Tamaulipas on the Rio Grande. The Commission's boundary preservation mandate covers the limitrophe areas of the Rio Grande and Colorado Rivers, as well as demarcation of the land boundary west of El Paso, TX. Two principal agreements between the United States and Mexico guide the IBWC's water management mission: a 1906 Convention on the Equitable Distribution of the Waters of the Rio Grande, and a 1944 Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and the Rio Grande.

Implementation of the IBWC's treaty responsibilities frequently requires specific agreements for the planning, construction, operation and maintenance of joint works and projects, as well as for changes and adjustments to operational matters. Major decisions of the Commission are subject to the approval of the two governments and are recorded as formal "Minutes," 320 of which have been concluded to date. Figures X and Y describe the Commission's two most recent Minutes concerning various aspects of Colorado River and Tijuana River basin water management, while Figure Z concerns efforts by the Commission to bring attention to the impact of stormwater challenges that have arisen as a result of climate change in the Ambos Nogales region at the Arizona-Sonora boundary.

Figure X: IBWC Minute 319 and Colorado River Water Resource Management

The culmination of a succession of IBWC Minutes developed to promote binational cooperation in countering the impact of protracted drought in the U.S. southwest and northern Mexico, Minute 319 entered into force in November 2012 on a five-year pilot basis. The Minute established a complex package of mutual obligations to improve overall management of the Colorado River and guide U.S. and Mexican authorities in the design of future approaches to the challenges of climate change. It established innovative and adaptive approaches within the strictures of the two countries' 1944 Water Treaty to diminishing water supply and growing demand in the border region. Importantly, Mexico agreed to share the loss of potential cuts to water usage with U.S. states under specified conditions, while also gaining a right to any eventual surplus water in the system. The Minute also provided for investment in water conservation projects in Mexico by U.S. governmental and private entities to improve the efficiency of the conveyance of the 1.5 million acre-feet of Colorado River water delivered to Mexico annually under the Treaty; these investments, currently underway, will form the basis for future innovative water ownership and exchange between Mexico and the United States.

Environmental restoration of the Colorado River delta was a further focus of Minute 319, leading to the first-ever release of a "pulse flow" through the river system, a long-standing goal of environmentalists in both countries. In 2016, U.S. and Mexican officials have engaged in intensive consultations that seek to design an agreement to succeed Minute 319 once it sunsets at the end of 2017. While the persistent and intensified drought conditions in the basin have complicated this task, they also point to the necessity of reaching a follow-up agreement to

Minute 319.

Figure Y: IBWC Minute 320 and Tijuana River Basin Cooperation

The transboundary Tijuana River basin, stretches across a 1,750 square mile area that comprises San Ysidro, California and Tijuana, Baja California, and is subject to a number of flood control, wastewater management, solid waste, and sediment control challenges that require close coordination among the responsible technical authorities and other stakeholders in the United States and Mexico. Stormwater flows containing sediment, trash and high concentrations of industrial, agricultural, and urban pollutants threaten the Tijuana River basin's natural resources and the growing population on both sides of the boundary.

While public and private interests on both sides of the border have cooperated on an ad hoc basis for many decades, the absence of an exclusively Tijuana River basin-focused process for systematically considering water-related boundary issues and proposing solutions to them meant that there was no coordinated way for the disparate stakeholders to set priorities. IBWC Minute 320 was adopted in late 2015 and created a consultative mechanism for jointly identifying, prioritizing and addressing such issues, with the goal of contributing to a more sustainable management of the basin, while at the same time encouraging enhanced civic participation in the process. A Binational Consultative Group (BCG) chaired by the U.S. and Mexican sections of the IBWC serves as a clearinghouse for recommending cooperative measures under the Minute 320 process. Other U.S. federal departments (such as EPA and the U.S. Army Corps of Engineers), state and local governmental entities (for example, the Regional Water Quality Control Board and the City of San Diego), and non-governmental organizations (such as Surfrider and Wild Coast) round out the diverse group of stakeholders that will help guide better coordinated and more optimal action in meeting the water-related issues affecting transboundary communities; Mexican participation in the BCG mirrors that of the United States.

Figure Z: Border Sanitation and Stormwater Issues at Nogales, Arizona

The cities of Nogales, AZ and Nogales, Sonora have long presented a microcosm of the type of water and sanitation issues that arise when close proximity, explosive population growth, and a particular topography combine at the United States-Mexico border; the intensified storm events occasioned by climate change have only exacerbated the situation. The U.S. and Mexico have cooperated in wastewater treatment since the 1950s to handle effluent from Mexico that flows from the much larger and faster-growing city of Nogales, Sonora. While the volume of effluent emanating from Mexico has increased disproportionately due to such growth, the infrastructure for conveying the flows has deteriorated and is now well past its useful life, requiring substantial upgrading to avoid eventual failure and the significant negative environmental impact that would result.

Stormwater management also constitutes a major challenge. A combined natural wash and manmade tunnel system conveys floodwaters through the two municipalities during the brief but intense summer monsoon season, but is proving increasingly inadequate for the task. Greatly diminished rainfall absorption capacity by the ground in the rapidly urbanizing territory of Nogales has combined with the more intense rainfall events associated with climate change to

greatly overload the system, leading to blown manhole covers and street flooding in both cities. The substantial potential for failure of the portion of the stormwater tunnel system that undergirds the boundary at the downtown port of entry has led the IBWC to call for the forging of a binational approach to address the matter. This process will involve cooperation by federal, state and local authorities from both countries, as well as non-governmental and other stakeholders, to avert a potential catastrophe. The State Dept is an active participant in the discussions surrounding how to mitigate this problem. State is formally engaging the relevant Mexican federal government authorities to encourage Mexico to make the needed repairs to the system on its side of the border. The Consulate General in Nogales is also bringing together stakeholders at the local level from both sides of the border to encourage the municipalities to take steps to remedy the problem.

Border Environment Cooperation Commission-North American Development Bank

In 1993, the North American Free Trade Agreement between the U.S. and Mexico created two binational institutions the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB). The institutions were capitalized in equal parts by the United States and Mexico and are mandated to preserve, protect and enhance the environment of the border region in order to advance the well-being of the people of the United States and Mexico. The joint BECC-NADB Board of Directors is made up of the Department of State, Department of Treasury, the Environmental Protection Agency, Mexican federal counterparts, and state and local representatives from the border region. The Department of State also directly funds BECC operations in the amount of roughly $2.4 million annually.

BECC, located in Ciudad Juarez, Chihuahua, and NADB, located in San Antonio, Texas, constitute an innovative, bi-national approach to infrastructure development and financing in the border region. Within this cooperative framework, BECC and NADB form a multidisciplinary team charged with developing, certifying, financing and verifying the impact of environmental infrastructure projects in five key sectors: water, waste management, air quality or urban mobility, clean and renewable energy, and energy efficiency. BECC personnel concentrate on analyzing the technical viability, environmental impact and community support for each project, while NADB personnel analyze and structure the financial and legal aspects of the project, as well as provide implementation oversight. The Board of Directors has sole approval authority for each project proposed for NADB financing.

Project Certification

Analyzing the environmental and social impacts and risks of infrastructure projects is becoming more and more indispensable for both public and private financial institutions worldwide. BECC and NADB offer comprehensive support to public entities and private companies in the planning, development, implementation, supervision and results measurement of environmental infrastructure projects. To be eligible for financing, projects must pass through a comprehensive, but flexible, certification process that serves to validate the environmental benefits, degree of social acceptance and financial viability of a project.

Project Financing

Over the course of 20 years, the programs of BECC and NADB have evolved to offer companies

and local governments increasingly better financing mechanisms that translate into loans with competitive rates for terms of up to 25 years and the possibility of accessing grants. Through various programs, NADB has provided millions in grant financing from its retained earnings. Beginning in 2012, these funds have been channeled through the Community Assistance Program (CAP), which provides grants for up to US$500,000 for small environmental infrastructure projects. Most grants have been made through the EPA-funded Border Environment Infrastructure Fund (BEIF) for water and wastewater projects. EPA grant funding has been key to increasing wastewater treatment coverage along both sides of U.S.-Mexico border. In 1995 only 20% of the residents in the Mexican border communities received wastewater treatment and by 2012 more than 85% had service.

Technical Assistance and Capacity Building

The commitment of BECC and NADB to the development of border communities is also reflected in its technical assistance and institutional strengthening efforts. Both institutions offer grants for project development activities, such as feasibility and engineering studies, urban and regional planning, infrastructure need assessments and credit ratings for potential borrowers. BECC also supports capacity building through studies and various workshops, mainly on such topics as climate change and basic infrastructure. To date, more than 1500 participants have attended BECC trainings and workshops. Through the NADB's Utility Management Institute (UMI), 2,203 utility professionals, representing 200 communities, have received training.

Current Projects

[NOTE: Need to reference these stats] Since 1995, NADB has participated in 218 BECC-certified projects with US$2.59 billion in loans and grants, of which 97% has been disbursed for project implementation. To date, 172 projects certified by BECC and funded by NADB have been completed and are in operation. Overall 141 BECC-certified Water and Wastewater projects have provided new or improved services to more than 13 million border residents with a capacity to adequately treat more than 468 million gallons per day (MGD) of wastewater discharges, equivalent to the wastewater discharge of nearly 12.8 million people. BECC also certified 23 Solid Waste projects accommodating approximately 1,550 tons/day of waste previously disposed of in open or uncontrolled sites, benefiting 2.9 million people and implemented 12 Air Quality projects related to paving and urban mobility which eliminate approximately 170,000 tons per year of PM10, caused by vehicular traffic on unpaved roadways. In addition BECC has developed 26 Water Conservation projects estimated to save energy and to decrease water losses by approximately 330 MGD; enough to serve the average demands of some four million people. In the energy sector, BECC has supported the development of 29 Clean and Efficient Energy projects generating 1761 megawatts (MW) that is anticipated to offset demands of traditional fossil fuel based energy production, avoiding nearly 2.86 metric tons of carbon dioxide (CO2) per year with the annual generation of 5,417 Giga-watt hours (GWh) of energy from renewable sources.

As part of the project development process, the NADB and BECC Joint Technical Assistance Program (JTAP) provides technical assistance through grants or technical expertise that will promote the development of high-quality environmental infrastructure

projects and initiatives that could access NADB funding or Border 2020 or other special grants. BECC also administers the Project Development Assistance Program (PDAP) for project development and design for Border Environment Infrastructure Fund (BEIF) designated projects, both of which are funded by the U.S. Congress through EPA and are administered by BECC and NADB, respectively. PDAP grant funds, supported by EPA's US-Mexico Border Program are available for public [HYPERLINK "http://www.becc.org/certification-process/environmental-sectors/water-wastewater"] infrastructure projects identified through a program-specific prioritization process.

In 2015, NADB and BECC funded US$1.93 million in JTAP grants to support project development activities, sector studies and capacity-building seminars and through PDAP more than US$1 million in grants were approved for the development of seven water and wastewater projects. In 2015, B2020 grants, administered through BECC, totaled $713,799.

Climate Change Initiative

Developed by BECC under collaboration with EPA and in coordination with INECC, Greenhouse Gases Inventories were completed in 2010 for the six Mexican Border States. The inventories determined that by 2025, the six states would generate 31% of Mexico's total GHG emissions with only 19% of the population. Following the completion of those inventories, BECC, with support from Border 2020 USAID, LACRI and COLEF, continued work with the Mexican States of Baja California, Sonora, Chihuahua, Coahuila and Tamaulipas to complete state climate action plans (SCAPs), which identify mitigation policies. In Baja California, Coahuila, and Chihuahua, the SCAP's also include socio-economic micro and macro analysis of mitigation policies, as well as the quantification of reduction and costs, and the cost savings of the Greenhouse Gases Inventory.

III. Water Quality

a. Drinking Water and Wastewater

Since 1997, the U.S.-Mexico Border Water Infrastructure Program, funded by Congress through EPA, has awarded grants to water and wastewater systems in the border region through the Project Development Assistance Program (PDAP) for project development and design and the Border Environment Infrastructure Fund (BEIF) for construction programs administered by BECC and NADB, respectively. Notable accomplishments include:

- More than $47 million in PDAP technical assistance grants for project development in 160+ communities. Approximately 85% of these funds have led to projects already implemented or under development.
- $627.3 million in BEIF funds committed to the implementation of 112 water and wastewater projects in the United States and Mexico. Of that amount $594.2 million has been disbursed for project implementation, which represents 95% of the funds contracted for projects.
- Every project, whether located in the US or Mexico, has provided an environmental and human health benefit for the U.S.

In 2015, the BECC/NADB Board of Directors approved for certification 14 new projects and more than US$257 million in financing for implementation. Seven projects were related to water and wastewater improvements such as the first wastewater treatment system for Delicias, Chihuahua that will serve a community of 130,900 residents. The other approved projects included an industrial emission control system for a steel mill in Monclova, Coahuila, and the first cogeneration project to convert biogas to energy in Ciudad Juarez, Chihuahua. The steel mill pollution control system in Coahuila will prevent the emission of 30,700 metric tons/year of total suspended particles while the basic urban infrastructure for Playas de Rosarito, Baja California will include the paving or repaving of repaving 74,194 m2 of roads to prevent emission of 32.8 metric tons/year of PM_{10}.

Also completed in 2015 was the installation of 48,600 feet of new sewer lines in Nuevo Laredo, Tamaulipas that eliminated sewage spills and contaminated discharges into the Rio Grande, and an estimated 5.2 million gallons a day of sewage is being safely collected and delivered for proper treatment.

Impact Assessments

In 2008, BECC evaluated four communities located in Valle de Juarez, Chihuahua to assess the impact of basic sanitation infrastructure projects in the elimination of exposure to untreated wastewater. Following the construction and completion of the BECC certified projects, the four communities surveyed demonstrated that at least 88% of the residents connected to the wastewater collection system, of which received compliant wastewater treatment. Consequently the eradication of cesspools, latrines and raw sewage discharge point eliminated the risk of exposure during rainy seasons. (Evaluación del Impacto de la Infraestructura de Saneamiento Básico en Comunidades del Valle de Juárez, Chih. 2013-2014 [HYPERLINK "http://www.cocef.org/desarrollo-de-capacidades/publicaciones-e-informes/evaluacion-del-impacto-de-la-infraestructura-de-saneamiento-basico-en-comunidades-del-valle-de-juarez-chih-2013-2014" \l ".VyzfyhUrl_U"])

BECC also completed a statewide impact assessment for Baja California to evaluate wastewater projects that certified in Tijuana, Playas de Rosarito, Tecate and Mexicali. This assessment found that after projects were completed in three of the four communities, more than 90% of the population was connected to wastewater collection and treatment, while Playas de Rosarito achieved 65% of the population connected.

State Initiatives

The Texas Commission on Environmental Quality is working with El Paso Water Utilities (EPWU) to approve a direct reuse project of wastewater. EPWU currently has a pilot facility co-located at the Bustamante Wastewater Treatment Plant designed to purify treated wastewater in a four-step process; if approved, the 10 million gallons per day of purified water would be added directly to the distribution system.[1] At the 2015 Border 2020 National Coordinators Meeting state and federal officials from both the U.S. and Mexico were given a tour of the pilot plant by EPWU President/CEO John Balliew.

b. Storm water

Green Infrastructure Initiative
In 2015, BECC and NADB expanded their promotion of green infrastructure along the border, which focuses on showing communities how green strategies and technologies, such as reinstating native flora, redesigning mediums and sidewalks to capture stormwater onsite, and using permeable paving materials, can be gradually incorporated into existing urban infrastructure. Throughout the year, a total of five events were held, including the second annual Border Green Infrastructure Forum in Tucson, Arizona, and an interactive webinar to explore the current legal framework for promoting green infrastructure projects in Mexico. Two workshops involving a hands-on demonstration project were also hosted in San Luis Río Colorado, Sonora and Ramos Arizpe, Coahuila. The exercise focused on passive rainwater harvesting and reuse systems and the importance of planting native vegetation for restoring regional ecosystems.

IV. Energy efficiency and conservation

a. Changes in energy

BECC
Construction of the 1.35-MW cogeneration facility and improvements to the sludge management system at the South Wastewater Treatment Plant in Juarez, Chihuahua, began in July 2015 and will use biogas produced during sludge digestion to generate about 40% of electricity requirements of the treatment plant. This renewable energy alternative will help displace greenhouse gases produced by traditional fossil fuel-based energy generation. The remaining projects, one solar and three wind projects, will have 313.6 megawatts (MW) of new generation capacity, to displace 553,000 metric tons of CO_2 a year.

Projects completed or implemented in 2015 included the first cross-border renewable energy project and the first buses financed under the border-wide public transportation improvement program in Mexico. Through Mercader Financial, S.A. de C.V., 33 diesel-fueled buses were financed to expand the existing fleets of two public transportation companies in Sonora and Baja California. These new buses manufactured by DINA Camiones, S.A. de C.V., at a minimum comply with EPA 2004 standards, producing approximately 50% less nitrogen oxides (NOx) and hydrocarbons (HC) and nearly 24% less carbon dioxide (CO2) than older model buses currently in circulation.

The Energía Sierra Juarez 1 Wind Farm in near the California- Baja California border consists of 47 wind turbines and the electricity generated by the 155-MW wind farm is being purchased by San Diego Gas & Electric (SDG&E).

Energy/Water Audits
BECC, in coordination with Federal, State and Municipal Agencies in Mexico and the United States, have proposed a program to provide a comprehensive and systematic methodology for identifying and implementing cost effective energy conservation and renewable energy projects in water and wastewater utilities, which typically have heavy consumption and high energy costs, and high greenhouse gas emissions. The Energy Management Program prioritizes and conducts energy audits and renewable energy

feasibility studies in an effort to reduce GHG emissions and energy consumption while promoting water conservation. Theses audits provide Energy Management Plans and select projects for implementation, provide training as well as identify financing programs for implementing recommended projects, and monitor and evaluate the effectiveness of the program, including greenhouse gas reduction, capacity building, energy savings and energy cost reductions. In addition, BECC has conducted audits for water utilities to help monitor water consumption, establish meter benchmarking and evaluate rate structures. Water audit findings include unreliable meter data and billing systems, and inconsistent water pressure leading to breaks or leaks. Recommendations can include meter replacement, leak detection and installing updated reporting systems.

i. Renewable energy

1. Solar, wind power, other

Texas is unique in the United States in that it has an electrical grid (ERCOT) that supplies power to 90 percent of the state. Thus, energy in the grid produced in one part of the state could well be consumed in another part of the state. In the 32 border counties Texas has 2,349 MW of completed wind energy production, with 2,558 MW of new production under construction.[1] The 2.3 GW of wind power are part of Texas' 17.7 GW of wind power; the state-wide figure for total wind power ranks Texas first in installed wind capacity. Besides providing 9.98% of all in-state electricity production, or the equivalent of 4.1 million homes powered by wind in 2015, there are numerous environmental benefits of Texas' wind power:

- 2014 annual state water consumption savings: 13.1 billion gallons
- 2014 equivalent number of water bottles saved: 99.3 billion
- 2014 annual state carbon dioxide (CO2) emissions avoided: 25.1 million metric tons
- 2014 equivalent cars worth of emissions avoided: 5.3 million[1]

In March 2016, for the first time ever in a full month, wind power in Texas added more to the grid than coal power, contributing 21.4 percent to the grid's overall power, or 66 percent more than the 12.9 percent from coal. On March 23, 2016 wind provided 48.28 percent--nearly half--of ERCOT's total grid load.[1]

ii. Change from coal to natural gas

b. Binational cooperation

Mexico's Comisión Federal de Electricidad has several high voltage interconnections with the transmission systems of various utilities along the US-Mexico border that are used for permanent and emergency transmission of electricity.[1] These include interconnections Southern California Edison and the Baja California region, El Paso and the Norte region, and Eagle Pass.

There are interconnections between Texas and Mexico for natural gas. A pipeline originates in Mexico to allow the shipment of petroleum naptha derived from natural gas to storage tanks in Hidalgo County. The naphtha is then shipped by pipeline to the Port of Harlingen where it is shipped via the Intracoastal Waterway to Corpus Christi. The Trans-Pecos Pipeline has been proposed to ship Permian Basin natural gas to Mexico.[1]

These current and proposed interconnections create a need for close binational cooperation. In September 2015 Governor Greg Abbott of Texas traveled to Mexico City and met with Mexican President Enrique Peña Nieto and Foreign Minister Claudia Ruiz Massieu. One outcome of the meeting was Governor Abbott's creation of a Texas-Mexico Energy Task Force, whose goals include continuing to strengthen and modernize the "interconnected electric and natural gas infrastructure."[1]

V. Air Quality

a. Monitoring and Mitigation/Pollution Reduction

EPA

Addressing mobile source emissions and impacts from US/Mexico trade

Ports of Entry can be a major source of pollution due to the high volume of personal vehicle and diesel truck traffic that crosses the border. Emissions from the ports are a major priority of the Region's border program. For example, the San Ysidro Port of Entry is the busiest land port in the world, accounting for almost 20% of all personal vehicle and pedestrian crossings on the U.S.-Mexico Border.

The San Diego Air Pollution Control District, with funding from Region 9, has installed a $PM_{2.5}$ air quality monitor at the San Ysidro Port of Entry. This monitor will operate for two years ending in January 2017 and will provide data on the air quality impact to the local community. The District is scheduled to issue a final report in summer 2017.

Using a methodology developed by the Federal Highway Administration that estimates emissions from vehicles crossing the ports of entry, EPA has provided funding to estimate emissions at the Calexico (California) and the Mariposa (Arizona) ports of entry. The results of these studies can used by local, state, and federal agencies responsible for planning new ports or expansion to existing ports to minimize emissions.

$PM_{2.5}$ Monitoring in Mexicali

With funding from EPA, the California Air Resources Board is operating two PM2.5 monitors in Mexicali for the next two years. Air quality from these monitors will help inform both countries of the international transport of $PM_{2.5}$. (Imperial County is in non-attainment for $PM_{2.5}$and has been successful in making a CAA Section 179(b) showing that it would have been in attainment, but for pollution from Mexico.)

PM10 Monitoring in Nogales, Sonora

With funding from EPA, the State of Arizona recently completed two years of $PM_{2.5}$ monitoring in Nogales, Sonora. Air quality data from these monitors will help inform both countries of the international transport of PM_{10} in the region.

b. Transportation, goods movement & manufacturing

EPA/California/NADB

The State of California has promulgated regulations that require diesel trucks and buses that operate in California to be upgraded or replaced to reduce emissions. Beginning in January 2012, newer heavier trucks and buses had to be equipped with air pollution filters. By January 2015, certain older trucks had to be replaced. By January 1, 2023, nearly all trucks and buses will need to have 2010 model year engines or equivalent. The regulation applies to all heavy duty diesel fueled trucks and buses that cross at California ports of entry. The State of California has an active enforcement program at the two commercial ports to ensure compliance with these requirements.

The North American Development Bank is financing the Border Wide Transportation Project, which provide loans to public bus companies in Mexico for the purchase of new buses that meet Mexico's newest diesel emission requirements. The North American Development Bank has provided $205 million in loans to local and state governments in Baja California and Sonora to pave roads which reduces particulate matter emissions.

Although not related to mobile sources, the use of fireworks and open burning is a source of greenhouse gas and particulate matter emissions during the holiday season in Mexicali. For the past five years, Region 9 has provided funding to the Imperial County Air Pollution Control District to implement a campaign to discourage such practices by airing public service announcements on local television and distributing outreach materials to local schools.

Texas

The TCEQ, with federal Clean Air Act Section 105 funds, contracted with Texas A&M Transportation Institute (TTI) to undertake border transportation studies, including one on drayage trucks in Laredo-Nuevo Laredo, and another on fuel-efficient driving for heavy-duty diesel trucks in El Paso. The drayage (short-haul, cross-border transport of trade) activity study in Laredo, completed in 2015, characterized activity from drayage trucks at the Laredo-Nuevo Laredo port of entry, the largest border POE for trucks. Study results will improve air quality planning in the area.[1] TTI in 2009 reviewed five of the 25 EPA SmartWay technologies, choosing the ones that best fit drayage trucks in the El Paso-Ciudad Juárez area and concluding that the best way to reduce emissions and conserve fuel was through efficient driving techniques. TTI is currently performing a study, to be completed in 2017, to quantify emission reductions and fuel savings.[1]

VI. Challenges to implementing federal programs, e.g. funding, capacity, political pressure.

Section to be added upon initial Report Draft to allow all Board Members from federal agencies to review and provide input.

[1] https://www.epa.gov/sites/production/files/2016-01/documents/symposium_proceeding_final_jan_21_2016.pdf

[1] [HYPERLINK "http://www2.epa.gov/pesticide-worker-safety/epa-proposes-stronger-standards-people-applying-riskiest-pesticides"]

[1] El Paso Water Utilities Public Service Board. "El Paso Officially Launches 'First-of-its kind' Water Reuse Project." Accessed May 6, 2016. [HYPERLINK "http://www.epwu.org/public_information/news_releases/nr_150828-01.html"]

[1] Public Utility Commission, "Recurring Reports." Accessed May 5, 2016. [HYPERLINK "http://www.puc.texas.gov/industry/electric/reports/Default.aspx"] .

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[1] "Depressed Texas power prices mean cheap electricity, plant closures." Houston Chronicle, April 9, 2016. Accessed April 11, 2016. [HYPERLINK "http://www.houstonchronicle.com/business/energy/article/Depressed-Texas-power-prices-mean-cheap-7238350.php?cmpid=gsa-chron-result"]

[1] TransAmerica Interconnections: Mexico strengthens and expands ties with the United States and Central America. Rosales, Miguel Ángel Ávila. T&D World Magazine. December 1 2011. http://tdworld.com/overhead-transmission/transamerica-interconnections

[1] https://www.texastribune.org/2015/07/14/pristine-big-bend-pipeline-could-run-through-it/

[1] Office of Governor Greg Abbott. "Governor Abbot Signs Transportation Agreement with Mexico; Announces Energy Task Force." Accessed May 6, 2016. [HYPERLINK "http://gov.texas.gov/news/press-release/21389"]

[1] Zietsman, Joe and Birt, Farzaneh, Johnson and Gu. "Characterizing Drayage Activities and Emissions in the Laredo-Nuevo Laredo Airshed." Texas A&M Transportation Institute. Review Draft. December 2015.

[1] "Binational Diesel Emissions Reduction." Texas Commission on Environmental Quality Contract #582-16-62566. April 27, 2016.

Chapter Three: Case Studies Promoting Environmental Resilience and Prevention of Damage From Climate Risks

Water Risks

The combination of increased temperatures, reduced precipitation, and ongoing drought associated with climate risks threaten surface and subsurface water supplies for residential, commercial, agricultural, and ecosystem maintenance purposes. Many of the resultant risks are transborder in nature and can be most effectively addressed through bilateral cooperation in the border region. The most obvious challenges are effective management of the binational Rio Grande and Colorado River systems and support of state aquifer management programs.

The 2016 SECURE Water Report illustrates "several increased risks to western United States water resources during the 21st century." This report follows the first report to Congress, which was produced in 2011. Specific projections include:

- "a temperature increase of 5-7 degrees Fahrenheit by the end of the century;
- A precipitation increase over the northwestern and north-central portions of the Western U.S. and a decrease over the southwestern and south-central areas;
- A decrease for almost all of the April 1st snowpack, a standard benchmark measurement used to project river basin runoff; and
- a 7 to 27 percent decrease in April to July stream flow in several river basins, including the Colorado, the Rio Grande, and the San Joaquin."[1]

There are many factors, from urbanization to tree cover to high energy demand, affecting water quantity and quality in the U.S.- Mexico border region. Cities along the border have started to implement programs and policies to help combat these negative effects, however there is still much more that can and should be done.

Effect of urban development on water flows and flood risk

Urban development has significantly affected natural water flows and hydrological patterns. Construction generally involves removing native vegetation and soil, which alters the natural landscape and vegetation that helps to slowly capture and filter stormwater, provide air purification benefits, and provide habitat for animals. As development changes the landscape from "green" or natural to "grey," there is often a loss in permeable surfaces, which can lead to an acceleration of stormwater runoff into low-lying areas. This affects the natural stormwater flow and changes our expectations of "flood zones" and how we must prepare for extreme weather events, which we expect will increase as the climate changes.

Green stormwater infrastructure can help play a crucial role in mitigating the negative effect development has on the permeability of our changing urban landscape: "Wet-season runoff from a neighborhood in Seattle, Washington, was reduced by 98 percent by reducing the width of the street and incorporating vegetated swales and native plants in the street right-of-way. Urbanization generally increases the size and frequency of floods and may expose communities to increasing flood hazards."[1] Tree canopies are increasing in some of the border cities thanks to changes in local policy, however more can be done to support landscapes that increase our resilience in terms of extreme weather events and extreme heat. Risks to our water quality and water quantity will be addressed further in this report, and it is important to understand how we can support development and policy that mitigates these negative effects of climate change. As an example of policies or initiatives that support water conservation, the City of San Diego and the Imperial Irrigation District have an agreement whereby the City reimburses the District the costs to reduce water delivery losses by installing best management practices. The City ultimately benefits from the resulting water savings.

Another effective solution is the transition from grey infrastructure to green stormwater infrastructure. Green stormwater infrastructure (GSI), including bioswales and raingardens, can help to capture and filter water onsite instead of diverting it into stormwater systems or onto roads or property. Tucson is a leader in terms of green stormwater infrastructure implementation and research has shown the numerous benefits:

> *"Results from modeling show GSI can have a significant impact on both large and small storm events. GSI resulted in reducing the 100-year 3-hour event peaks by 24%, 19% and 10% in the Valencia, El Vado, and Santa Clara watersheds respectively. GSI implemented throughout these watersheds in our 25-year scenario will result in over $2.5 million dollars of annual community benefits as a result of flood reductions, water conservation, property value increases, reduced urban heat island impacts, improved stormwater quality, reduced heating and cooling needs, air quality improvements, and the energy associated with pumping CAP water and groundwater in Tucson" (Watershed Management Group).*[1]

As explained in the Desert Canopy study completed in 2014, Phoenix has a 9% tree cover that has an annual benefit of $6.11 million in terms of stormwater capture and filtering. El Paso has a 5.1% tree cover that has an annual benefit of $2.1 million per year. Albuquerque, New Mexico has a 13.3% tree cover which has a $3.42 million / year benefit in terms of avoided stormwater runoff. Las Cruces, NM has a 3.7% tree cover which has an annual benefit of $58,900 per year in terms of stormwater filtration and capture.[1] By adopting smart tree canopy and green stormwater infrastructure policies, the U.S. Mexico border cities can not only become more resilient in terms of flash flooding and extreme heat, but also improve air quality through increased carbon sequestration, increase walkability through reduced urban heat island, and reduce peak energy demand while increasing property values: "a 20-percent tree canopy over a house results in annual cooling savings of 8 to 18% and annual heating savings of 2 to 8%."[1]

Effects of drought on community water supplies and irrigation

Both the Colorado and Rio Grande River supplies are shared by the US and Mexico according to the 1944 Treaty. Both rivers have suffered droughts and extreme flood conditions several times since the signing of the Treaty. Both rivers have experienced low flow conditions during the last

15 years. Although, Rio Grande below the Rio Conches has benefited from rains the last two years resulting in increased storage in reservoirs in Mexico. This storage will be shared according to the Treaty between the two countries. Storage levels in the upper Rio Grande remain low, resulting in reduced storage in Elephant Butte Reservoir and below normal irrigation allocations in the Rio Grande Project. However, there is currently an above average snow pack in the head waters of the Rio Grande.

The Colorado River basin is suffering a brutal 16-year drought. The only exceptional snowpack accumulated during the winter of 2010. All of the Colorado River storage is located in the US and has hovered around 49% of total capacity for the last four years. All US water right holders and Mexico have been able to take their full annual allocations during these years. A shortage sharing agreement was signed among the Upper and Lower Basin States in 2007. This Agreement outlines a shortage sharing arrangement when Lake Powell and Lake Mead reach certain critical elevations. Mexico has also agreed, as set forth in the Treaty, to sharing shortages if Lake Mead reaches elevation 1075.

As mentioned in Section Two of this report, the IBWC is an international organization comprised of U.S. (USIBWC) and Mexican sections with joint responsibility for applying various boundary and water treaties between the United States and Mexico and settling any differences that arise. IBWC's mission relates to climate change challenges principally in the execution of its water distribution and flood control responsibilities. Implementation of the IBWC's treaty responsibilities frequently requires specific agreements for the planning, construction, operation and maintenance of joint works and projects, as well as for changes and adjustments to operational matters. Major decisions of the Commission are subject to the approval of the two governments and are recorded as formal "**Minutes**," 320 of which have been concluded to date. Figure Z (text box) concerns efforts by the Commission to bring attention to the impact of stormwater challenges that have arisen as a result of climate change in the Ambos Nogales region at the Arizona-Sonora boundary. Minute 319 and subsequent Minutes being negotiated between the US and Mexico will further define shortage sharing between the two countries on the Colorado River.

Border sanitation and stormwater issues at Nogales, Arizona

The cities of Nogales, Arizona and Nogales, Sonora have long presented a microcosm of the type of water and sanitation issues that arise when close proximity, explosive population growth, and a particular topography combine at the United States-Mexico border; the intensified storm events occasioned by climate change have only exacerbated the situation. The United States and Mexico have cooperated in wastewater treatment since the 1950s to handle effluent from Mexico that flows from the much larger and faster-growing city of Nogales, Sonora. While the volume of effluent emanating from Mexico has increased disproportionately due to such growth, the infrastructure for conveying the flows has deteriorated and is now well past its useful life, requiring substantial upgrading to avoid eventual failure and the significant negative environmental impact that would result. Stormwater management also constitutes a major challenge. A combination natural wash and manmade tunnel system conveys floodwaters through the two municipalities during the brief but intense summer monsoon season, but is proving increasingly inadequate for the task. Greatly diminished rainfall absorption capacity by the ground in the rapidly urbanizing territory of Nogales, Sonora has combined with the more intense rainfall events associated with climate change to greatly overload the system, leading to

blown manhole covers and street flooding in both cities.

Overflowing sewers discharge untreated sewage to the Nogales Wash. Poor pretreatment of industrial wastewater further compounds public health and water supply risks in both countries. Disinfection activities assist with immediate health concerns, but also create favorable conditions for oxidation of heavy metals that may be present in sewage overflows (i.e. hexavalent chromium). Groundwater monitoring in the Nogales, Arizona has detected high levels of nitrates above regulatory standards, which is likely associated with sewage contamination.

Impacts of stormwater on infrastructure has led the IBWC to call for the forging of a binational approach to address the matter. This process will of necessity involve federal, state and local authorities from both countries, as well as non-governmental and other stakeholders, to avert a potential catastrophe.

Climate-change impacts on limited water supply

Nogales, Arizona's water supply relies mainly on micro-groundwater basins located along the Santa Cruz River located east of the city that are recharged by ephemeral runoff. The city also depends on the Portrero Well Field located east of the Nogales Wash. Although it is a more reliable water supply, the Portrero Well field water levels are steadily declining, and require treatment for arsenic. As such, the Santa Cruz River microbasins are the city's preferred water supply source. Nogales, Sonora's main water supply is the Los Alisos well field located south of the Nogales watershed divide. Supply is supplemented by groundwater infiltration galleries located along the Santa Cruz River in Sonora, and wells located within the Nogales sub-watershed. Los Alisos also hosts a wastewater treatment plant (LAWTP) constructed for the purpose of offsetting excess wastewater discharges to Arizona, and improving the water balance in that basin.

In the Upper Santa Cruz River Basin, climate change is expected to increase the frequency of dry summers, and the frequen**cy of both wet and dry winters.**[1] This will complicate management decisions for the water utilities that serve Ambos Nogales, and will have significant implications for water quality, quantity, and the ecosystem services supported by the Santa Cruz River in Arizona. Of concern:

- Dryer summers coupled with wetter winters could shift the distribution of Nogales sanitary sewer overflows to the winter months. This may augment infiltration of contaminated stormwater on downstream water supplies while impacting ecosystems.
- Dryer summer and winter seasons could negatively impact the Santa Cruz River microbasins in Arizona, forcing the U.S. municipality to rely on lower-quality water from the Portrero well field.
- Under Minute 276, a binational agreement executed in 1988 between the United States and Mexico by the International Boundary and Water Commission (IBWC), Mexico has no obligation to send wastewater to the Arizona. Seasonal uncertainties in rainfall may encourage diminished wastewater deliveries to Arizona via treatment at the LAWTP for recharge of Sonoran water supplies.
- Less wastewater deliveries to the NIWTP in Arizona will impact recharge of downstream

Arizona water supplies, the perennial flow of the Santa Cruz River, and the sustainability of established and rare ecosystems that the river currently supports.

Santa Cruz River, Audobon IBA at the Chavez Siding Road Crossing[1]
Pre-NIWWTP Upgrade and Los Alisos Diversions
Photo taken by John Shasky, Friends of the Santa Cruz River Volunteer; used with permission.
June, 2004

Santa Cruz River, Audobon IBA at the Chavez Siding Road Crossing[1]
Post-NIWWTP Upgrade and Los Alisos Diversions
Photo taken by John Shasky, Friends of the Santa Cruz River Volunteer; used with permission.
May, 2014

Climate change impacts on ecosystem services

Surface flows in the Santa Cruz River provide many ecosystem services, such as vegetation and habitat for wildlife, as well as recharge to groundwater resources for water provisioning. The USGS has mapped and quantified the biophysical and socioeconomic impacts resulting from various scenarios associated diminished deliveries of Sonoran wastewater to the Nogales International Wastewater Treatment Plant (NIWTP) in Arizona. Based on various varying effluent release scenarios from Sonora, the USGS Santa Cruz Ecosystem Portfolio Model summarizes Arizona impacts to community real estate values; an Audubon Society Important Bird Area (IBA) that hosts endangered birds, the Tumacácori National Historical Park (TNHP); and the extent of Santa Cruz River perennial flow which hosts **the endangered Gila Topminnow.**[1]

The USGS predicts that a 17% reduction in wastewater deliveries to the NIWTP will negatively impact real estate values in the downstream community of Tubac by a combined $1M; will impair the IBA; and will impact the perennial extent of the river by at least two miles. The worst case scenario considers no further deliveries of wastewater from Sonora. In this case, real estate values in Tubac and Tumacácori are impacted by over $11M combined; perennial flows through the TNHP are eliminated; and at least twelve miles of Santa Cruz River perennial habitat is lost.

Most recently, the perennial extent of the Santa Cruz River has diminished as a result of **improved recharge of effluent**[1,1]. This resulted from decreased ammonia concentrations associated with an upgrade to the NIWTP in 2009. Although perennial reach has been lost, improved effluent quality has also resulted in the rediscovery of the endangered Gila Topminnow downstream of the NIWTP, thus putting more at stake should the river be entirely lost.

Recommendations

The IBWC's Minute 319, executed in accordance with the 1944 U.S.-Mexico Water Treaty, established new rules in sharing Colorado River water while providing plans to address current challenges along the river over a five year period that terminates at the end of 2017. In response to earthquake damage to irrigation canals in Mexicali, the Minute allows Mexico to store some of its Colorado River Water in Lake Mead. In exchange, the U.S. may send less water to Mexico during drought years. Minute 319 is an excellent example of adaptive responses to changing conditions on the ground.

Binational partnerships similar to those that facilitated Minute 319 can support the development of an amendment to Minute 276, focused on diminishing uncertainties resulting from Mexico's claims on the return of effluent. Understanding the cost/benefit of having Sonoran wastewater treated in Rio Rico, Arizona vs. Los Alisos, Sonora could help with the development of such an amendment while minimizing risks associated with expected climate-change scenarios.

Possible area of investigation in support of a new minute

- Identify opportunities for water savings through investments in aging Ambos Nogales water distribution infrastructure as a means to offset demand for overdrawn water supplies being recharged by the LAWTP. This may help buffer impacts associated with water supply uncertainties tied to climate change.
- Investigate opportunities for assisting Nogales, Sonora in advancing investments in its municipal pretreatment program. This will lower operation and maintenance costs for both the NIWTP and the LAWTP, and may diminish the environmental risks from sanitary sewer overflows.
- Investigate opportunities for securing south-flowing effluent for Sonora (i.e. Douglas, Agua Prieta) in exchange for securing north flowing effluent for Arizona (i.e. Ambos Nogales, Santa Cruz River) as a means to buffer impacts from climate change on both communities.

Recommendations (ADEQ)

Minute 319 updates the 1944 U.S. Mexico Water Treaty with Mexico by establishing new rules in sharing Colorado River water while providing plans to address current challenges along the river over the next five years. In response to earthquake damage to irrigation canals in Mexicali, the minute allows Mexico to store some of its Colorado River Water in Lake Mead. In exchange, the U.S. may send less water to Mexico during drought years. Minute 319 is an excellent example of amending past agreements in order to adjust to changing conditions on the ground.

Binational partnerships similar to those that facilitated Minute 319 can support the development of an amendment to Minute 276, focused on coordinating with Mexico on efficient management of binational effluent in the context of expected climate-change scenarios.

Possible area of investigation in support of a new minute:

- Identify opportunities for water savings through investments in aging Ambos Nogales water distribution infrastructure as a means to offset demand for overdrawn water supplies being recharged by the LAWTP. This may help buffer impacts associated with water supply uncertainties tied to climate change.

- Nogales, Sonora is indebted to IBWC for costs associated with treatment of Sonoran wastewater in Arizona. IBWC may consider debt forgiveness in exchange for verified Nogales, Sonora investments in its municipal pretreatment program. This will lower operation and maintenance costs for both the NIWTP and the LAWTP, and may diminish the environmental risks from sanitary sewer overflows.
- Investigate opportunities for securing south-flowing effluent for Sonora (i.e. Douglas, Agua Prieta) in exchange for securing north flowing effluent for Arizona (i.e. Ambos Nogales, Santa Cruz River) as a means to buffer impacts from climate change on both communities.

Stormwater and Sewage Capacity Issues

During the summer monsoon, stormwater infiltration impacts the IOI's conveyance capacity. This causes upstream sewers to overflow and discharge untreated sewage to the Nogales Wash. Poor pretreatment of industrial wastewater further compounds public health and water supply risks in both countries, particularly during sanitary sewer overflows (SSOs). Disinfection activities assist with immediate health concerns, but also create favorable conditions for oxidation of heavy metals that may be present in SSOs (i.e. hexavalent chromium). Groundwater monitoring in the Nogales, Arizona have detected high levels of nitrates above regulatory standards, which is likely associated with sewage contamination.

Stormwater infiltration also contributes wear-and-tear of the IOI through scour, and creates operational challenges for the NIWTP. Stormwater also carries improperly-disposed solid waste, directly impacting natural areas including the Santa Cruz River and the TNHP. The Nogales Wash is listed as impaired for E. coli (1998), chlorine (1996), ammonia and copper (2004). The Santa Cruz River downstream of the NIWTP is listed as impaired for total residual chlorine and ammonia (2010), cadmium, and E.Coli (2012/14).

Link between climate change impacts and impacts on limited water supply--Sanitary Sewer Overflows

Nogales, Arizona's water supply relies mainly on micro-groundwater basins located along the Santa Cruz River located east of the city. The microbasins are recharged by ephemeral runoff, so the city also depends on the Portrero Well Field located east of the Nogales Wash. The Portrero Well field water levels are steadily declining, and require treatment for arsenic. As such, the Santa Cruz River microbasins are the city's preferred water supply source.
Nogales, Sonora's main water supply is the Los Alisos well field located south of the Nogales watershed divide. Supply is supplemented by groundwater infiltration galleries located along the Santa Cruz River in Sonora, and wells located within the Nogales sub-watershed. Los Alisos also hosts a wastewater treatment plant (LAWTP) constructed for the purpose of offsetting excess discharges to Arizona, and improving the water balance in that basin.

In 2014, the Hydrologic Research Center (HRC)[1] modeled local climate change in the Upper Santa Cruz Basin, and its implications for water resource management. HRC's analysis predicts an increase in the frequency of dry summers, and an increase in the frequency of both wet and dry winters. The resulting uncertainty increases the complexity of management decisions for the public utilities that serve Ambos Nogales. This has significant implications for water quality,

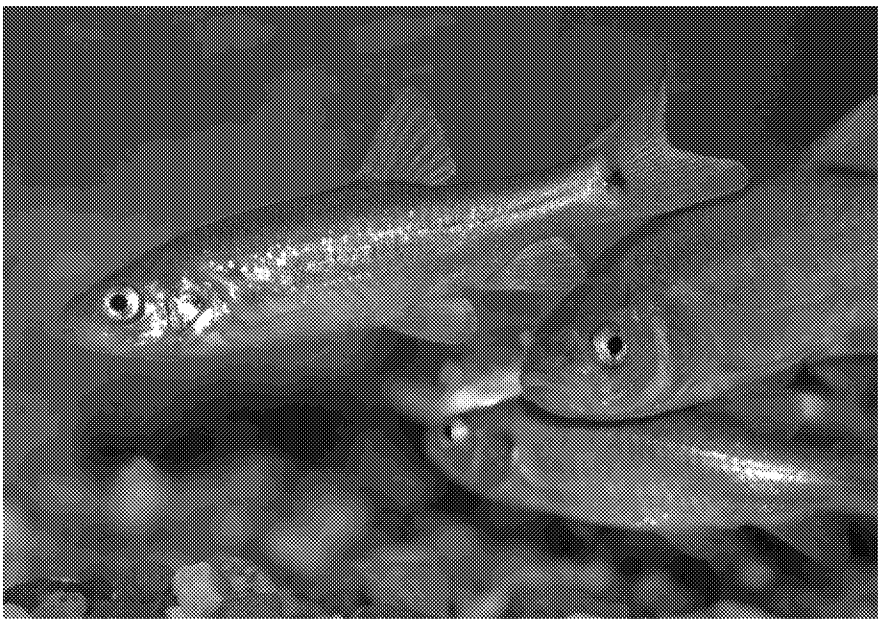
quantity, and the ecosystem services supported by the Santa Cruz River. Of concern:

- Dryer summers coupled with wetter winters could shift the distribution of sanitary sewer overflows to the winter months, which may augment infiltration of contaminated stormwater.
- Dryer summer and winter seasons could negatively impact the Santa Cruz River microbasins in Arizona, forcing Nogales to rely on lower-quality water from non-renewable water supplies in the Portrero well field.
- Under Minute 276, a binational agreement executed in 1988 between the Mexico and the United States, Mexico has no obligation to send wastewater to the NIWTP. Seasonal uncertainties in rainfall may encourage diminished wastewater deliveries to Arizona via treatment at the LAWTP for recharge of Sonoran water supplies.
- Less wastewater deliveries to the NIWTP in Arizona will impact recharge of downstream Arizona water supplies, the perennial flow of the Santa Cruz River, and the sustainability of established ecosystems that the river supports.

Endangered desert fish of the southwest border region may be threatened by a changing climate

Response to Drought at Leslie Canyon National Wildlife Refuge

The Southwestern Border region of the United States has always been challenged by the availability of water. Historic droughts have sometimes extended for decades. In response to these conditions aquatic species in the area have very restricted distribution and have also been challenged by introductions of invasive fish species. At Leslie Canyon National Wildlife Refuge in southeast Arizona, wildlife managers are collaborating with private landowners to help desert fish adapt to rapidly changing climatic conditions. The 2,765-acre refuge was established in 1988 to protect the Yaqui topminnow and the Yaqui chub; two mosquito-eating fish that are in danger of extinction because of loss of their wetland habitat and competition with non-native species.



Perennial flow in Leslie Creek is dependent upon an ample winter snowpack on the adjacent 9,796-foot Chiricahua Mountains, which slowly melts providing a steady source of fresh water. Ongoing long-term drought conditions are now impacting this region, and there is an expectation that future climate change will further reduce available water. For example, the annual snowpack has been more than 50% below normal, resulting in less stream flow and sometimes even zero year-round water.

To help sustain the native fish populations, the U.S. Fish and Wildlife Service has worked with ranchers upstream from the refuge to purchase conservation easements, establish a Safe Harbor Agreement, and introduce the rare fish into suitable wetlands on the private ranches that are less threatened by reduced water. This formal process is a win-win situation for everyone involved. It provides for landscape protection and conservation of rare animals on private property, which remain on local tax rolls instead of being owned by the federal government. It enables ranchers to restore endangered species on their private lands without any risk imposed by laws that might otherwise negatively impact their management activities and use of their property. Finally, it helps build positive relationships between wildlife managers and ranchers as they work together to keep large areas of the landscape intact and healthy during adverse environmental conditions. Through this cooperation, desert fish that have lived in these harsh conditions for millennia will have a chance to survive the expected changes in climate.

Mitigation efforts of the USDA-Natural Resources Conservation Service

Effective mitigation efforts include irrigation technologies and management strategies to improve across the border region as cooperators strive to efficiently utilize water resources. The USDA-Natural Resources Conservation Service (NRCS) has funded multiple Regional Conservation Partnership Program (RCPP) projects in Texas. One RCPP example is the Texas Water Resource Institute project focused on reducing nutrient and sediment loading in this region, as well as improving agricultural water use efficiency in the Rio Grande Valley.

Mitigation efforts are also being addressed through USDA climate hubs which are located across

the country. The El Reno, Okla. office deals directly with central U.S. issues. An emphasis has been placed on the development of regional forecasts and assessments for weather hazards so land managers can incorporate and implement adaptive planning strategies.

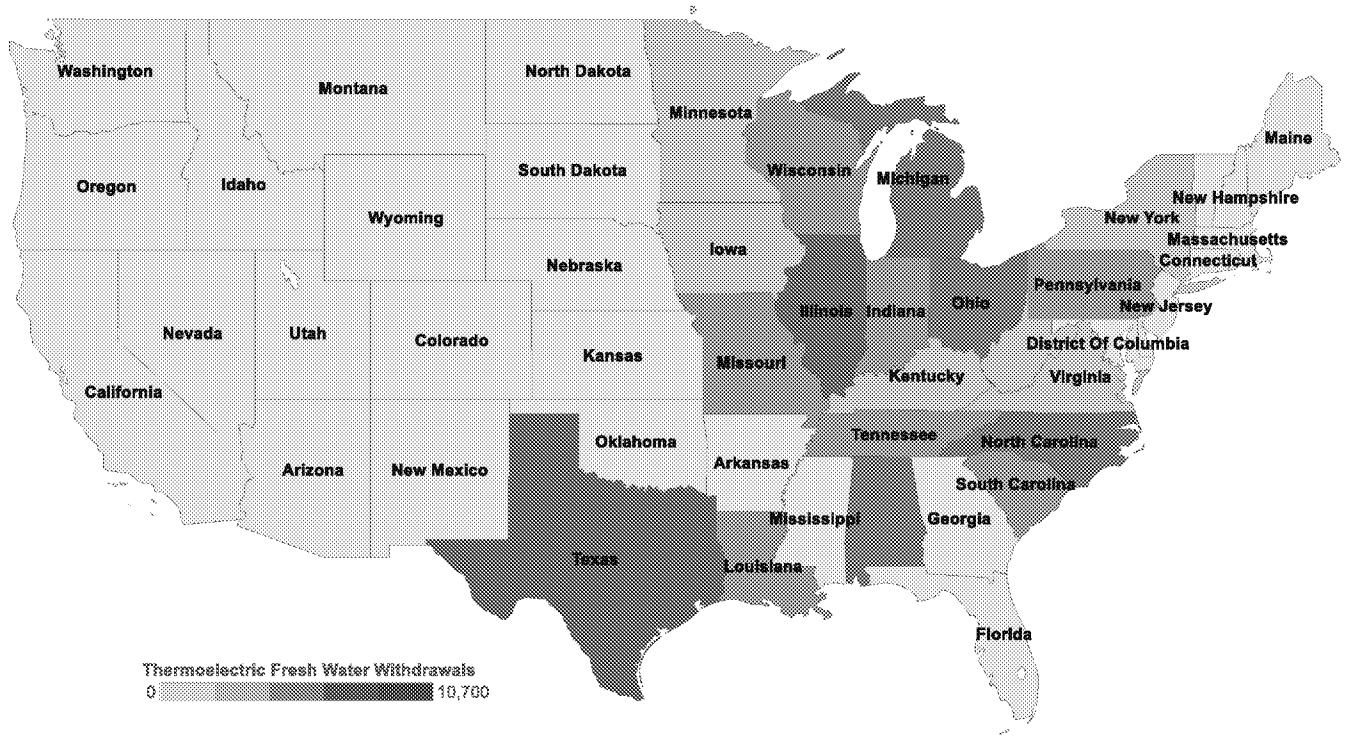
NRCS's Small Watershed Program focuses on assisting local sponsors with the planning, design, and construction of flood water retention structures. In some cases, they may also provide for water supply, irrigation, or municipal and industrial purposes. Over the years, many of the structures that were originally based in rural areas have been impacted by urbanization. So, under rehabilitation funding, these structures have been updated to meet current state criteria so they play a very important role in flood mitigation. Rehabilitation efforts are under way for projects in South Texas and Arizona.

The Energy-Water Nexus

Water and energy are closely intertwined. Energy is needed to purify and distribute water while water is needed to generate energy. The cost of electricity accounts for approximately 80 percent of the total cost of municipal water processing and distribution.[1] Thermoelectric power is the single largest user of water in the United States, accounting for more than 45% of total water withdrawals in 2010.[1] Thermoelectric power plants use water for steam production and cooling in order to generate electricity.[1] Growing demand for limited water supplies places growing pressure on the energy sector to seek alternative approaches. The water-energy nexus is becoming increasingly more important especially along the US-Mexico border which faces growing water scarcity challenges, exacerbated by climate change, population growth and industrial expansion.

Water use can be defined in terms of withdrawal and consumption. Water consumption is the use of water that is not returned to the environment, usually due to evaporation.[1] Withdrawal is the total amount of water that is removed from a groundwater or surface water source, some of which may get returned to its source, consumed or made available for use elsewhere. Water withdrawn by thermoelectric power plants for cooling but not consumed, can be returned to the environment at a higher temperature (sometimes exceeding 90°F) which can harm fish and wildlife.[1] Nearly three quarters of the total amount of water withdrawn by thermoelectric power plants is freshwater.[1] The largest total withdrawals for thermoelectric power were in Texas (11,000 million gallons per day), where nearly all withdrawals were from freshwater sources.[1] The Southwest U.S. is facing rapid population growth, rising electricity demand and declining water resources.[1] Continued reliance on thermoelectric power plants under a business-as-usual scenario, would reduce the amount of water stored in Lake Mead in Nevada and Arizona, and Lake Powell in Utah and Arizona, for example, by 50% below the long-term historical average (1971-2007) by 2050.[1]

Thermoelectric Freshwater Withdrawals (Million Gallons/ Day)



SOURCE: U.S. GEOLOGICAL SURVEY CIRCULAR (2010)

One of the consequences of the energy-water nexus is a less stable and less reliable grid. The extreme drought in Texas in 2011 caused a 6% increase in electricity generation and a 9% increase in water consumption for electricity. [1] Water shortages and higher water temperatures caused by ongoing drought in the Southwest U.S. is revealing the vulnerability of thermoelectric power plants. On average, a 1 °C rise in ambient cooling water temperature can cause power output to drop up to 0.5%.[1] Hydroelectricity generation in California has dropped nearly 50% since 2013, as the state continues to be afflicted by the worst drought in memory. In 2015, hydroelectricity provided less than 7% of California's overall electricity generation, down from 13% in 2013. Since October 2011 through the end of the 2015, California experienced a reduction of around 57,000 GWh of hydroelectricity which caused electricity costs to increase by approximately $2.0 billion. Replacing the reduction in hydroelectricity with natural gas also led to a 10% increase in carbon dioxide emissions and other pollutants.[1]

Lower Lake Mead Levels and their Hydropower Generation at Hoover Dam

Although the Bureau of Reclamation is installing more efficient turbines to generate electricity with lower head elevations at Hoover Dam, if water storage elevation continues to decline, power generation will decrease. Much of Arizona, Southern California and Southern Nevada depends on Hoover generated power to supply a large percentage of their firm power demand. Because, by law California will not use coal generated power, it will be hit the hardest by reduced Hoover supplies. Rolling brown outs could be the results unless more power is imported from states outside the southwest or new NG or other firm power generation is brought on line.

Water-stressed areas along the U.S.-Mexico border

Although the United States and Mexico in general are not considered water scarce countries,

unequal water distribution, pollution, population growth and overuse have led to significant water stress along the U.S.-Mexico border. 28% of Mexico's total renewable water is located in the arid north and central regions which produce 77% of Mexico's GDP and house 68% of its population. Pollution in the north further decreases the availability of usable water. Nearly 50% of Mexico City's water is classified as heavily polluted. [1] Constraints on Mexico's limited water resources will likely only increase with significant economic growth and expansion of its manufacturing and energy sectors as the population increases. Electricity generation is expected to increase 24% by 2040 in the U.S. and will likely increase much more in Mexico.[1] According to the U.S. Energy Information Administration (EIA), Mexico's electricity capacity increased nearly 25% from 2004 to 2014, with fossil fuel power plants accounting for 78% of the country's electricity generation. Water for thermoelectric power plant cooling accounted for 5% of Mexico's water withdrawals in 2009. Agriculture is Mexico's most water-intensive industry, accounting for 77% of total use, with the industrial, energy and municipal sectors accounting for the remainder of extractions. [1]

MIT researchers predict that 5 billion or 52% of the world's projected 9.7 billion people will be living in water-stressed areas by 2050, with an additional 1 billion people living in areas where water demand exceeds surface-water supply.[1] Climate change is reducing renewable surface and groundwater resources along the U.S.-Mexico border, posing a major concern to energy security. Arizona and California are two of seven U.S. states that share the Colorado River with Mexico. Recent droughts have impacted the water supply across the West, with reservoir levels along the Colorado River dwindling to 40-year lows.[1] The border region of southern New Mexico, Far West Texas and Chihuahua, Mexico is challenged by: 1) limited surface and groundwater supplies that are becoming increasingly saline; 2) increasing water demands due to a growing population and demand from irrigated agriculture; 3) water quality impacts from agricultural, municipal, and industrial discharges to the river; (4) rising temperatures and increased frequency and intensity of drought and extreme weather events.[1] According to Mexico's National Water Commission (CONAGUA), much of the northern and central Mexico are under high or very high levels of water stress, with 40% to 132% of the region's renewable water resources are already allocated.[1]

Impact on Agriculture and Other Uses

Human consumption and use of groundwater has contributed to society in terms of public health, agricultural productivity, economic development and food security. However, groundwater extraction has surpassed recharge rates in numerous locations around the world including the Southwest U.S. As energy demand increases with population growth, other uses of water such as agriculture, manufacturing, drinking water and sanitation services for cities face increasing competition for limited water resources.

U.S. Water Withdrawal by Type in 2010[1]

Thermoelectric	45%
Irrigation	32%
Industrial	4%

Public Supply	12%
Other	7%

Mexico Water Withdrawal by Type in 2009[1]

Agriculture	77%
Municipal	14%
Thermoelectric	5%
Industrial	4%

Under business-as-usual electricity generation in the South Platte Basin that includes the Denver metropolitan area, for example, on average 16% less water would be available for agriculture over summer in 2040 compared to 2010.[1] The vulnerabilities in water and energy supply pose critical risks for food security, as severe droughts and fluctuations in energy prices can affect the availability, affordability and accessibility of food over time. Renewable energy sources such as solar PV and wind do not require fuel processing and associated water inputs to generate electricity and are consequently more resilient to extreme weather events and severe droughts. PV and wind can improve access to and sustainability of water supply for agriculture and other uses. In addition, solar PV and onshore wind projects provide opportunities for multipurpose land use

Recommendations: A Renewable Energy Solution to the Energy-Water Nexus

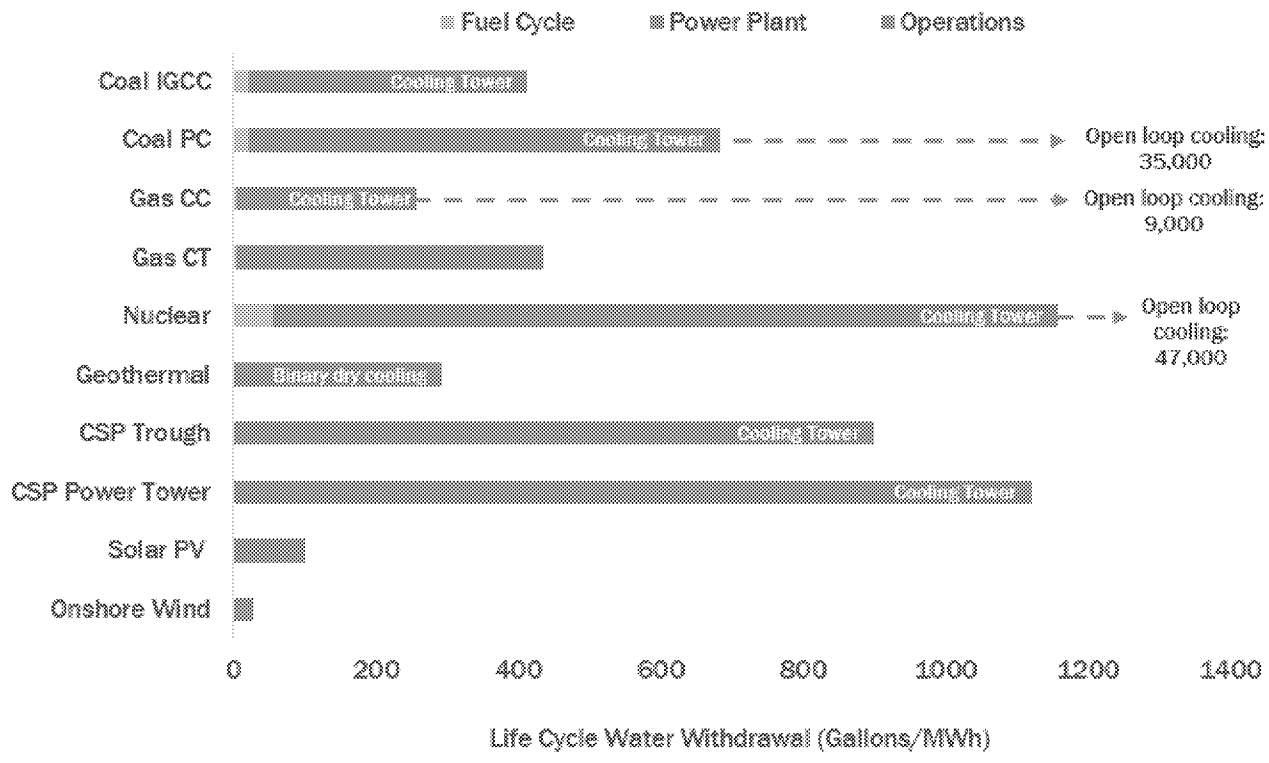
In addition to providing a solution to energy security and climate change, renewable energy can help address water scarcity and minimize the impacts of the energy-water nexus. In its World Energy Outlook 2012, the International Energy Agency (IEA) concluded that energy sector scenarios with higher shares of renewable energy require much less water. The American Wind Energy Association estimated electricity generated from wind energy in the United States avoided the consumption of more than 130 billion liters of water in 2013, equivalent to the annual water consumption of over 320,000 U.S. households.[1]

Recommendations: Energy Management Workshops

EPA Region 6 has conducted several energy management workshops for the water and wastewater utilities along the U.S. – Mexico border. These workshops highlighted ways to reduce energy consumption and costs by using the ISO 50,001 Energy Management Systems framework and EPA's Energy Star Guidelines for Energy Management. However, the water and wastewater utilities along the border have not yet adopted these energy management practices.

NEED RECOMMENDATION

Median Life Cycle Water Withdrawal by Energy Source[1]



Note: CSP= concentrating solar power; CT= combustion turbine; CC= combined cycle; IGCC= integrated gasification combined cycle; PC= pulverized coal.
The life cycle water withdrawal of selected electricity generating technologies depicted in the graph above is based on median harmonized estimates and includes component manufacturing, fuel acquisition, processing, and transport, and power plant operation and decommissioning.[1]

Solar Photovoltaic (PV) Case Study

Solar PV uses up to 300 times less water than conventional energy by directly converting sunlight to electricity without the use of water.[1] On average, U.S. thermoelectric power plants withdraw 19,000 gallons to produce 1 MWh of electricity[1], compared to PV which withdraws approximately 5 gallons per MWh or less during operation.[1] Solar PV water consumption during operation is associated with cleaning modules. In most climates, PV modules do not require cleaning as dust is periodically removed by wind and rainfall. In humid, dust-prone climates, dry brush cleaning methods can be deployed to clean modules without water or electricity.[1]

By displacing conventional grid electricity, a PV array in the U.S. Southwest, can save up to 5,600 liters of life cycle water withdrawal per MWh.[1] In California, 25 First Solar PV power plants in various stages of development, construction, or operation (total capacity of 3.6GW) are projected to save more than 1.8 billion liters of water per year in operational water consumption (equivalent to approximately 730 Olympic-sized swimming pools). Solar PV is ideally suited to meet the energy needs of arid regions of the Southwest U.S. and Northern Mexico. Communities that generate a significant amount of electricity from renewable energy can be less susceptible to electricity disruption during droughts.

According to a study by the Union of Concerned Scientists, an electric system that relies on renewable sources such as wind, solar and geothermal to supply 80% of electricity demand and cuts energy use with energy efficiency programs would withdraw 50% less water by 2030 and 90% less by 2050 than business-as-usual scenario in the power sector.[1] In addition, renewable energy can help address the trade-offs between water, energy and food, bringing security of supply to all three sectors.

Changing Precipitation Patterns and Green Stormwater Infrastructure

As described in section xx, the border region will be facing an increasing number of extreme drought and flood events because of climate change. Traditional stormwater management systems or gray infrastructure is ill equipped to mitigate either of these extremes. Graywater infrastructure redirects rainfall into conduits making it unavailable for storage, irrigation, natural cleansing, or infiltration. Sizing for flood events would require costly overhauls of existing storm management systems. Green infrastructure provides a cost effective alternative that revives ecosystem services, adding to the border's resiliency.

Green infrastructure[1] (GI) is defined by the US EPA as a set of products, technologies and practices that use natural systems, or constructed systems that mimic natural processes to improve overall environmental quality and provide public services. The State of Vermont Green Stormwater Infrastructure Agency clarifies that "Green Stormwater Infrastructure (GSI) is a subcomponent of GI that specifically relates to the management and control of stormwater runoff and the protection of hydrologic function."[1] The Border Environment Cooperation Commission (BECC) has done much to increase border communities' understanding of these principles and techniques through its many educational forums. Increasingly, there are more examples of green stormwater infrastructure in municipalities [See photos – need], but the holistic adoption seems slow in coming. In 2015, no US border city received EPA/ BECC managed funding for green stormwater infrastructure projects (US. EPAa, 2016) (US. EPAb, 2016). **With increased funding and support, institutionalized policies and practices can improve conditions for the border communities.**

The Lower Rio Grande Valley (LRGV) Texas Pollutant Discharge Elimination System (TPDES) Stormwater Management Task Force is an organization that promotes green stormwater infrastructure (GSI) and low development through education and workshops. The LRGV Stormwater Task Force and its many conferences, trainings, demonstration projects and research is partly funded by an EPA 319(b) grant through the TCEQ. The organization assists 17 municipalities and counties across the Rio Grande Valley in complying with State and federal stormwater regulations and permits ([HYPERLINK "http://rgvstormwater.org/members/"]).

The LRGV, in partnership with Texas A&M–Kingsville, hosts an annual conference that brings together over 250 state and local government, private sector, and academic professionals to discuss new and innovative watershed, stormwater and flood management strategies and techniques. For over 10 years, EPA has presented various regulatory, technological and program topics at the conference in support of the LRGV Task Force's efforts to provide quality

education and transfer technology to professionals throughout the Rio Grande Valley, neighboring states and Mexico. Additionally, the LRGV Task Force and Texas A&M-Kingsville hosted green stormwater infrastructure /low impact development workshops in 2014 and 2015 to promote innovative watershed and stormwater management strategies, in which EPA staff participated and presented.

Decreased precipitation will stress already fragile local water supplies. Cities across the arid southwest have already imposed watering restrictions and incentive programs to replace turf and other water hungry landscaping for native vegetation. Capturing or storing stormwater runoff when it rains can help communities increase water supply reliability. Organizations, such as the San Diego Climate Collaborative (2016), already advocate for infiltration-based GI practices (e.g., raingardens, green streets) that allow rainwater to soak into the ground replenishing local groundwater reserves. Rainwater harvesting techniques (e.g., rain barrels, cisterns) can reduce demand for potable water for landscape irrigation in public parks and municipal buildings, or for non-potable uses such as toilet flushing and cooling systems.

According to a joint Issue Brief by the Natural Resources Defense Council and the Pacific Institute, (2014, p. 2), "In southern California and the San Francisco Bay Area, capturing runoff using these approaches can increase water supplies by as much as 630,000 acre feet each year. Capturing this volume, roughly equal to the amount of water used by the entire City of Los Angeles annually, would increase the sustainability of California's water supplies while at the same time reducing a leading cause of surface water pollution in the state."

The potential for extreme precipitation events is important for urban managers to consider because the amount of rain and duration of these events determine the needed design capacity of the stormwater infrastructure. Substantial increases in extreme precipitation events may result in the failure of stormwater systems if new extreme precipitation levels are outside their design envelope.

Extreme rain events come with their own challenges. The Assessment of Climate Change on the Southwest United States (Garfin, 2014) reports that highly structured and in-filled cities have little capacity to adapt to increasing flows and may be especially vulnerable to extreme flooding. Enhanced, intensified water flows will increase the wash-off of suspended sediments and other pollutants, degrading water quality. Altered flow regimes and degraded water quality also have significant implications for downstream ecosystems that receive polluted urban stormwater. There have been some initial efforts to restore such ecosystems.

According to Nielsen-Gammon, a professor at Texas A&M University, in the past century, precipitation in Texas is up 7 to 10 percent, and the frequency of two-day heavy rainfall spells has nearly doubled. (Satija, 2015) Four to six inch rainfalls is becoming more common in the Rio Grande Valley. In lieu of developing oversized stormwater infrastructure to combat these deluges, Brownsville is using resacas or historic river channels to help buffer the impacts of extreme flooding events. Efforts are underway to restore, enhance, and improve the natural

services of flood protection and water supply in the resacas through sedimentation removal. In phase 1 alone, the community has increased its storage capacity by 23.3 million gallons. (Mariscal, 2016) If all area resacas are restored, the City could direct up to 727 million gallons into these channels. As promising as this strategy appears for this coastal city, the unmet restoration costs moving forward are almost $170 million. (Mariscal, 2016) **Increased support for coastal areas is critical.**

Role of green stormwater infrastructure in addressing water quality and quantity risks

GI implemented at a broad scale has the potential to reduce stormwater pollution from the "First Flush" or the first half inch of rain that liberates the oils, grease, animal feces, brake dust, metals, and sediment that accumulate on our roofs and streets in between storm events. As water infiltrates roots and soil, bacteria breakdown hydrocarbons and other urban contaminants carried across imperious surfaces. According to a Watershed Management Group (2015, p. 29) research on rain garden performance indicated that "field studies in North Carolina showed a 70% removal rate for E. Coli and fecal coliform while a laboratory test saw an average removal rate of 91.6%. The same paper reported that removal rates for heavy metals are high as well, citing a study of parking lot features at the University of Maryland that experienced 57% removal rates for dissolved copper." For cities such as Las Cruces, NM soon to have its National Pollutant Discharge Elimination System (NPDES) stormwater permitting program green stormwater infrastructure as its primary management strategy to address water quality impairments, building professional and economic capacity to address health and environmental concerns is imperative. GSI helps slow runoff in developed and undeveloped areas, reduces surface erosion (meaning improved water quality), and filters the water slowly into the soil. In addition, roots from trees and other shrubbery helps to anchor soil, which minimizes erosion, and the vegetation helps build organic soil when allows or filtration and keeps nutrients in the ground. Green stormwater infrastructure supports improved human health and air quality, reduced energy demand, increased carbon storage, increased property values of up to 30%, increased recreation space, reduced ambient temperatures, flood prevention, and additional habitat for wildlife: "the value of green infrastructure actions is calculated by comparison to the cost of "hard" infrastructure alternatives, the value of avoided damages, or market preferences that enhance value (e.g. property value). Green infrastructure benefits generally can be divided into five categories of environmental protection: (1) Land-value, (2) Quality of life, (3) Public health, (4) Hazard mitigation, and (5) Regulatory compliance."[1]

In 2009, EPA, the U.S. Department of Housing and Urban Development (HUD), and the U.S. Department of Transportation (DOT) formed the Partnership for Sustainable Communities (PSC) to help communities access affordable housing and transportation, while protecting the environment. In 2010, PSC proactively began sponsoring intergovernmental livability summits, workshops, education and training on the technical and policy framework associated with the DOT-EPA-HUD livability initiative. Over 1,000 participants have been engaged and trained on major policy, guidance, and technical issues related to the Livability Initiative and GI.

EPA Region 6 and EPA's Office of Sustainable Communities have collaboratively awarded several Border communities with targeted technical assistance to provide tools for implementing

smart growth and development that assist with sustainable growth and economic expansion, while protecting human health and the environment. In 2010, the City of Las Cruces, NM received technical assistance under the [HYPERLINK "https://www.epa.gov/smartgrowth/smart-growth-implementation-assistance"] (https://www.epa.gov/smartgrowth/smart-growth-implementation-assistance) to develop a robust public participation model that included deliberative planning and visioning. The city requested assistance to develop strategies for community engagement, especially with ethnically diverse, low-income populations that had limited experience in community planning and design. Creative outreach and participation strategies focusing on images was tested during two workshops for the El Paseo corridor, a 1.7-mile area that extends southeast from Main Street in downtown Las Cruces to the New Mexico State University campus.

Through the Building Blocks Program, each of the communities listed below received technical assistance delivered by EPA staff, EPA-hired consultant teams and EPA-funded nonprofit organizations. Assistance included one or two-day public engagement workshops, direct consultation with relevant decision-makers, and a memo outlining specific steps each community could take to implement the ideas generated during their workshop.

- May 2012 – Corpus Christi, TX Walkability Audit to assist the city achieve their goals of walkable, sustainable neighborhoods and live-work districts; traffic calming; complete streets; connectivity; social life on streets; and, safe routes to schools.
- May 2013 – Vinton, TX Green Building workshop to assist the city identify policies that support compact development that feature sustainably built homes and buildings and strategies for incorporating smart growth policies into the village's existing land use plans and zoning code.
- June 2013 – Vinton, TX Smart Growth for Small and Rural Communities workshop to assist the city identify barriers to smart growth in local development codes, programs, and policies, and to help the city achieve their goals of sustainable sites and responsible land use development; resource conservation; energy conservation and atmospheric quality; water efficiency, conservation and management.
- February 2016 – City of Anthony, NM Small and Rural Communities workshop to assist the city identify barriers to smart growth in local development codes, programs, and policies, and to help the city achieve their goals of exploring strategies for revitalizing downtown, strengthening the local economy, planning for efficient infrastructure, and increasing housing options.

Through the [HYPERLINK "https://www.epa.gov/smartgrowth/local-foods-local-places"], sponsored by the U.S. Department of Agriculture (USDA), EPA, the Centers for Disease Control and Prevention (CDC), the U.S. Department of Transportation (DOT), the Appalachian Regional Commission (ARC), and the Delta Regional Authority (DRA), with support from the White House Rural Council, helps communities develop and implement action plans that promote local foods and downtown revitalization. In 2015, Vinton, TX received a Local Foods, Local Places workshop to support the city's goals of better access to healthy local food, a revitalized downtown that is the community's economic anchor, and more economic opportunities for local farmers and business. NEED RECOMMENDATION

Recommendation:

In terms of development and stormwater management, Federal Emergency Management Agency (FEMA) flood maps are usually used to understand flood hazards for the area. This process needs to be readdressed because these maps are often produced from streamflow data from a few decades ago: "floodplain managers need new peak streamflow data to update flood frequency analyses and flood maps in areas with recent urbanization"[1]. It is recommended that stormwater engineers and floodplain managers along the U.S. Mexico border utilize real-time data from streamflow-gaging stations when new development is being considered in an area: "stormwater managers can use streamflow information in combination with rainfall records to evaluate innovative solutions for reducing runoff from urban areas" (Konrad). Developing policy that incentivizes the incorporation of pervious surfaces into a development, based on recent streamflow data, can have positive implications for both our water quality and quantity in the U.S.- Mexico border region:

> *"impervious surfaces associated with urbanization alter the natural amount of water that takes each route. The consequences of this change are a decrease in the volume of water that percolates into the ground, and a resulting increase in volume and decrease in quality of surface water. These hydrological changes have significant implications for the quantity of fresh, clean water that is available for use by humans, fish and wildlife" (Center for Watershed Protection).*

As seen in the hydrograph[1] below, development and urbanization affects the streamflow rate after large and small storms. Because more and more areas of the watershed become paved, and thus impervious, this leads to higher and more rapid peak discharge, resulting in increased damage to homes and businesses. This can also lead to decreased dry weather flow in streams because less groundwater is being recharged (Center for Watershed Protection).

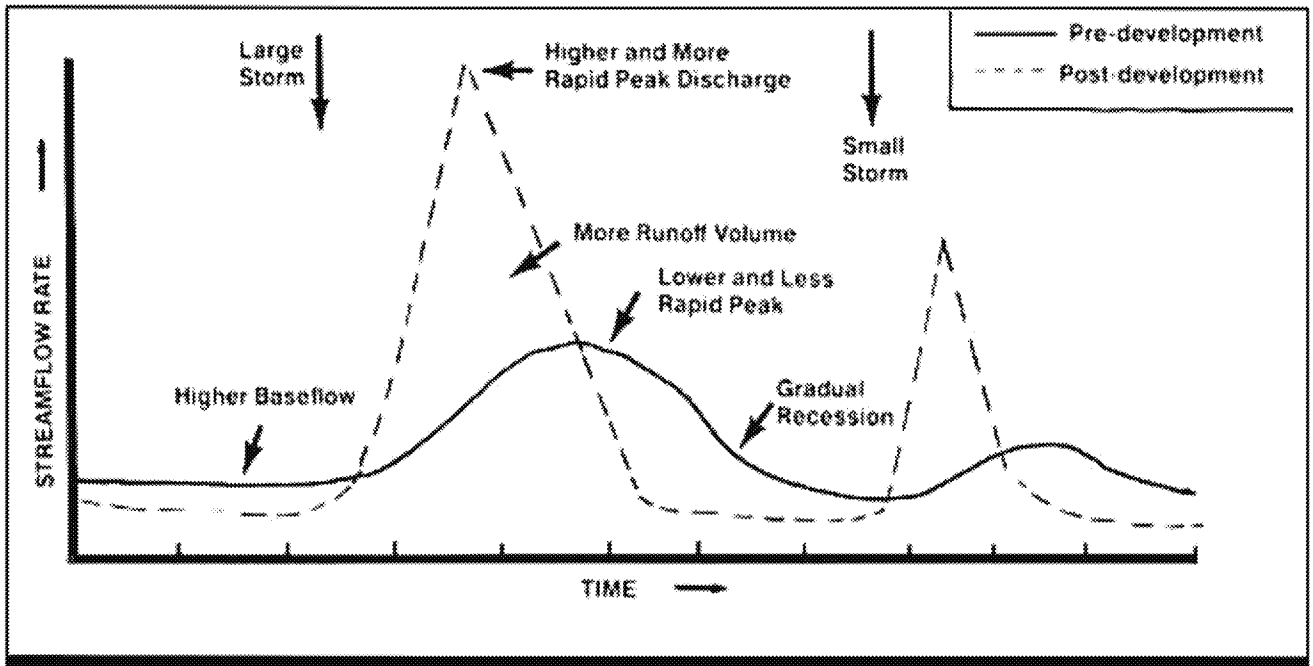


Figure 6: Altered Hydrograph in Response to Urbanization (Schueler, 1987)

Despite the fact there remain vast regions of undeveloped areas along the Texas and Mexico border, urban sprawl continues to pose an environmental threat. From 2006 through 2015, the three major urban areas along the border have lost 18,389 acres of land to development (see Appendix A). This is a five percent increase in urbanized or developed land. In the Lower Rio Grande Valley and El Paso areas, the land lost was dominated by cropland. The land lost to urbanization around Laredo was dominated by rangeland.

	Valley	Laredo	El Paso	Combined
2006 acres	218,896	32,497	102,605	353,998
2015 acres	227,698	36,429	108,260	372,387
Difference	8,802	3,932	5,655	18,389
% increase	4%	12%	6%	5%

Recommendation:

Because of the countless benefits of green stormwater infrastructure (GSI), cities along the U.S.-Mexico border should be supported in their efforts to adopt GSI policies and incentivize residents and businesses to incorporate GSI elements as well. In order to do this, cities will need direct funding to pilot GSI projects so data can be collected to explain the cost benefits and help drive the private sector to train their contractors. Direct funding should be provided to municipalities interested in roof assessments and green roof installations. Funding should also be provided to community groups or municipalities interested in organizing GSI conferences, such as the conference in Tucson, to educate City employees, contractors, residents and businesses about the proven benefits of GSI in their area. Direct financial incentives (at the federal level) should also be given to property owners who install green stormwater infrastructure. These

incentives could be in the form of tax credits for GSI implementation, reduced stormwater fees for properties that increase the permeability of their site, and/or rebates for GSI investments.

Currently, the National Association of City Transportation Officials (NACTO) has organized a committee to gather case studies and develop a green stormwater infrastructure guide for cities. The committee is reviewing best practices for the integration of GSI into transportation corridors for the purpose of stormwater management (NACTO's *GSI in Right-of-Way*). Once this NACTO guide is released, there needs to be a strong push from the federal government encouraging states and cities to adopt this NACTO design guide for GSI in the right-of-way.
Furthermore, local governments should be supported to implement programs which promote eco-roofs: "In 2007, New York City aimed to support the installation of extensive green roofs by enacting a property tax abatement to offset 35% of the installation cost of a green roof" (Foster). Demonstration projects on municipal buildings should be prioritized for funding from the federal government because they can act as educational showcases for residents and business owners who frequently visit City buildings. A cool roof demonstration project in Tucson, Arizona showed how energy costs could be cut in half (savings of $4,000 per month) by installing a white elastomeric coating on a 28,000-squart foot building.[1] City-specific research and GIS data analysis should be funded to show the increases in property values from GSI. Green stormwater infrastructure has many economic benefits and can help to jumpstart private investment in a couple of ways—GSI increases the property value of both residential and commercial space, which can help attract more business and homebuyers to the area: "In Philadelphia, green infrastructure improvements on vacant land increased property values as much as 30 percent" (Gordon). GSI provides jobs for technical experts who can install and maintain GSI.

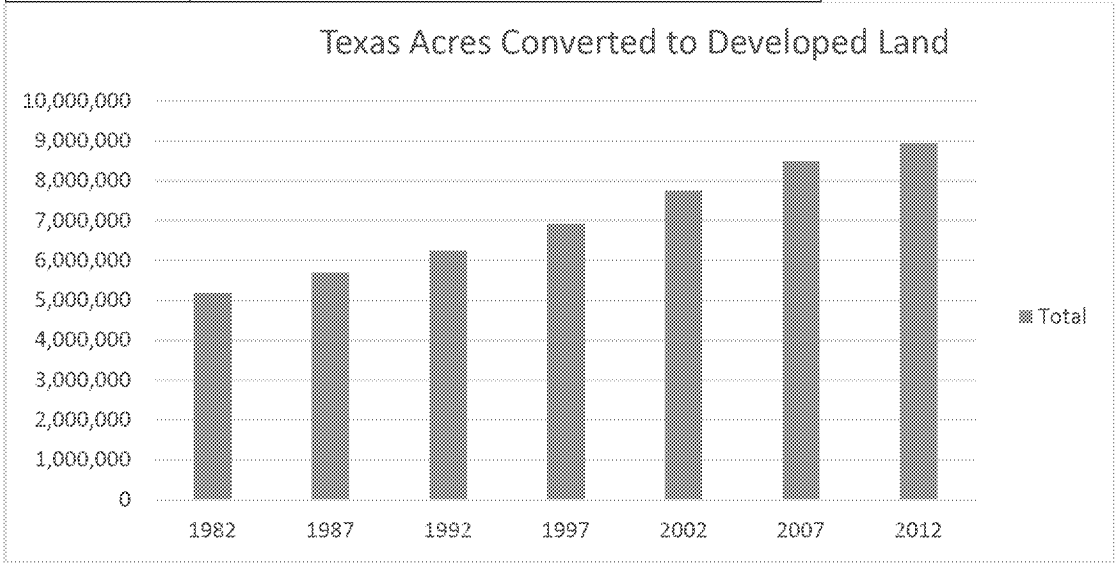
Recommendation:

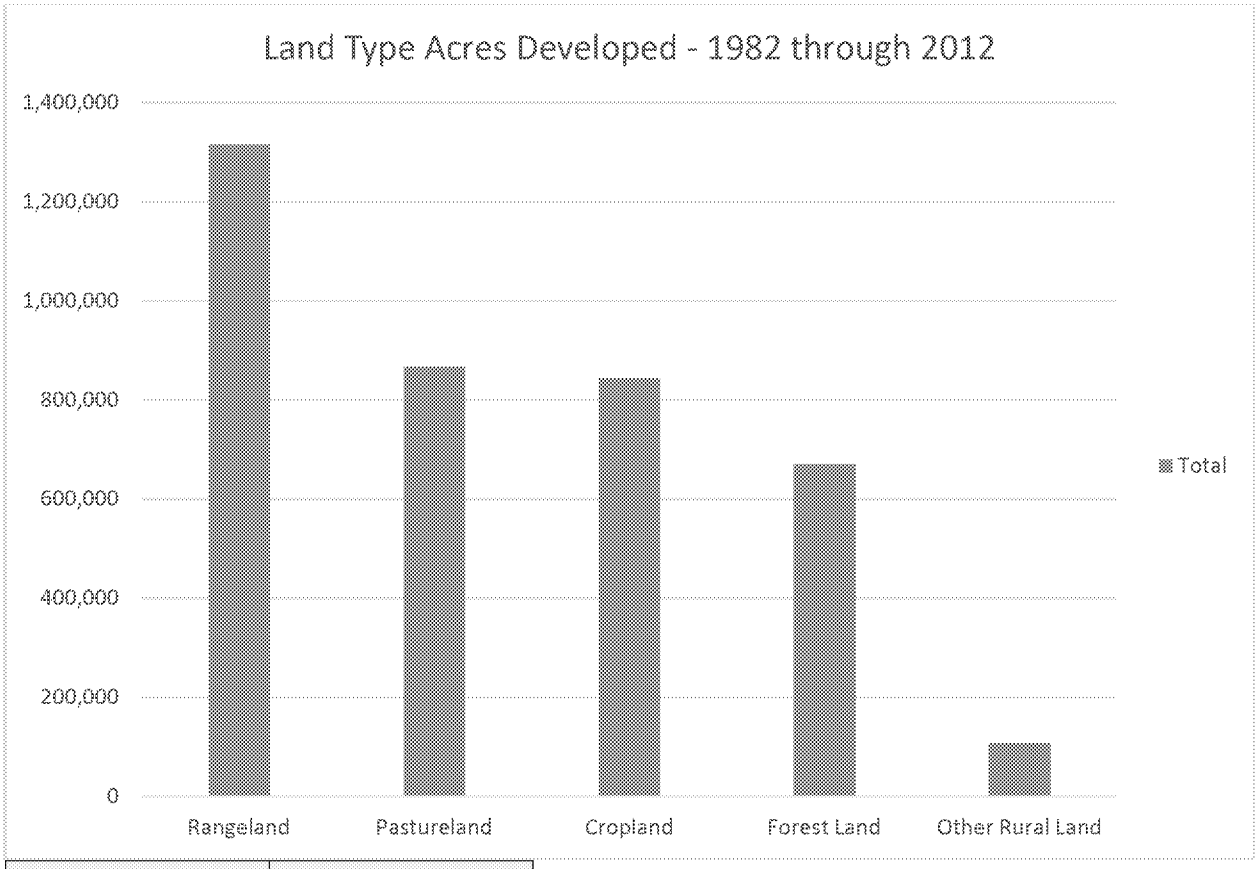
Support the development of a worker training program for green stormwater infrastructure in all U.S.-Mexico border cities. Green stormwater infrastructure training programs, such as the Green Infrastructure Worker Training Program in Syracuse, New York, offer certifications in Green Stormwater Infrastructure, which allows for consistent and well-trained maintenance.

> *"The Green Infrastructure Worker Training program, developed by the State University of New York and serving the Syracuse region, provides 10 weeks of instruction in green infrastructure job training. Low-income residents, particularly members of a refugee community in Syracuse, are targeted for the program. Participants devote six weeks to learning about gardening, landscape design and green infrastructure, with a 2- to 4-week internship with a local employer following. Participants who complete this program receive a 10-hour certification from the Occupational Safety and Health Administration (OSHA)."*[1]

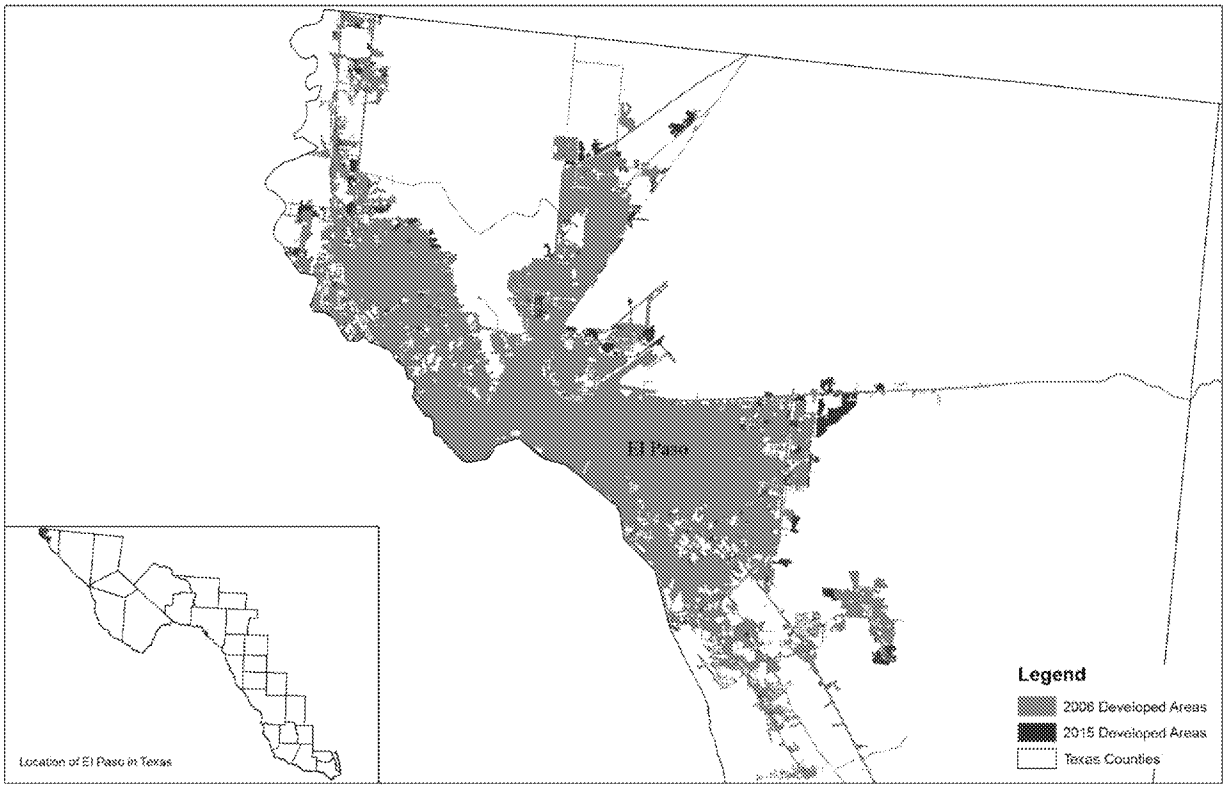
Appendix A: Urbanization and Urban Sprawl

Years	Acres of Developed Land
1982	5,188,000
1987	5,703,200
1992	6,249,000
1997	6,922,400
2002	7,749,100
2007	8,490,900
2012	8,936,600
Grand Total	**49,239,200**

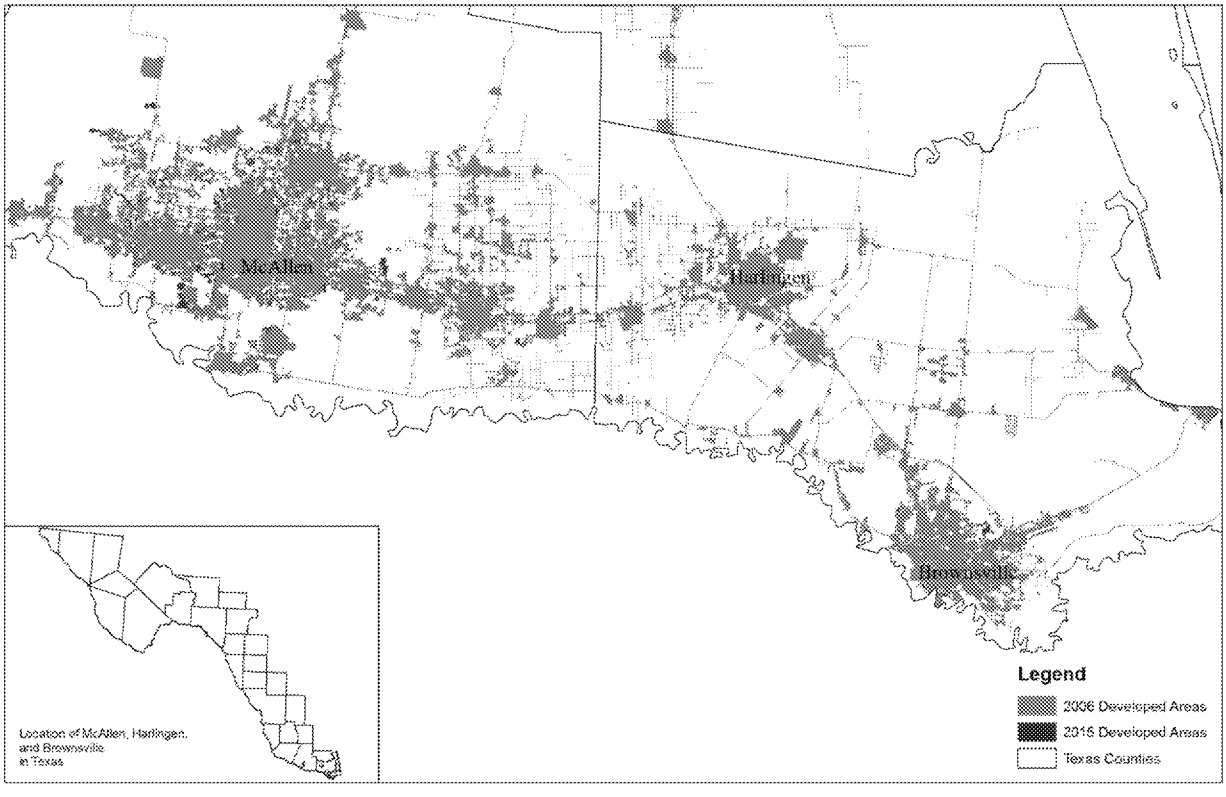




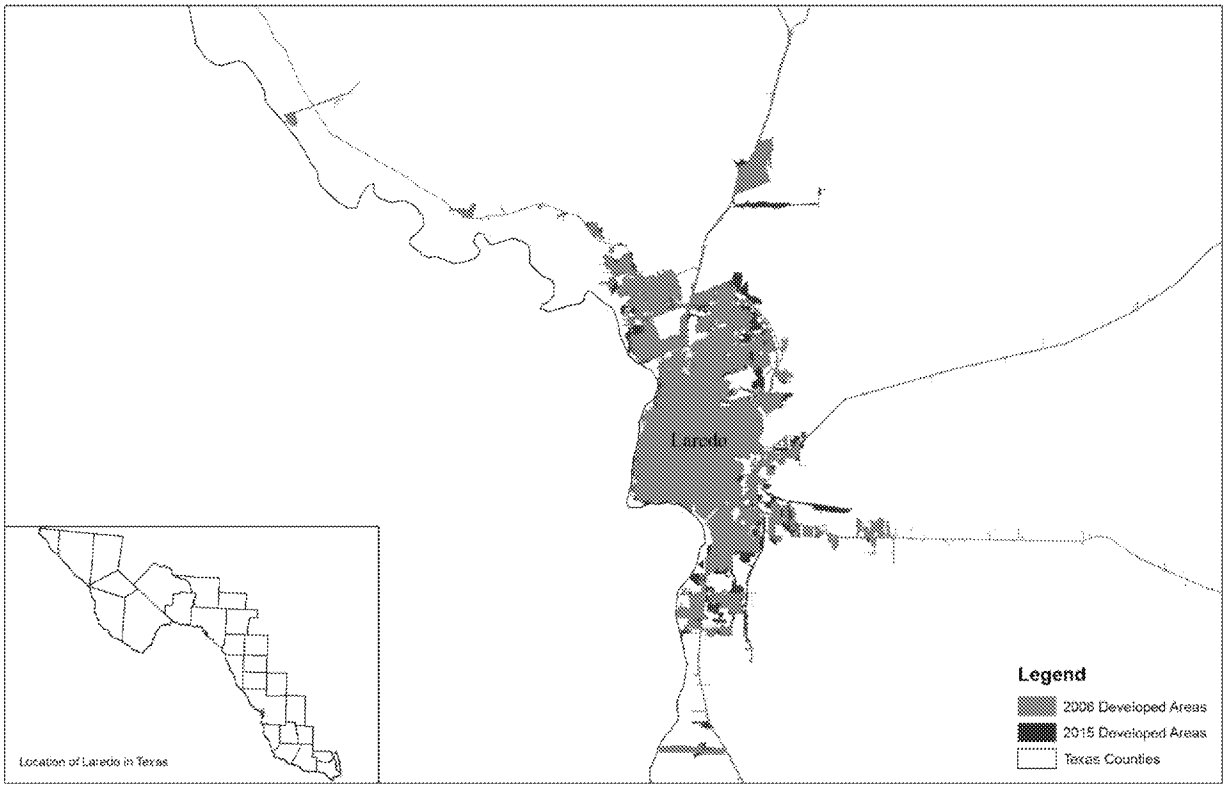
Land Type	Acres Developed
Rangeland	1,315,700
Pastureland	867,400
Cropland	844,700
Forest Land	671,600
Other Rural Land	108,200
Grand Total	**3,807,600**


El Paso
Location of El Paso in Texas
Legend
2006 Developed Areas
2015 Developed Areas
Texas Counties

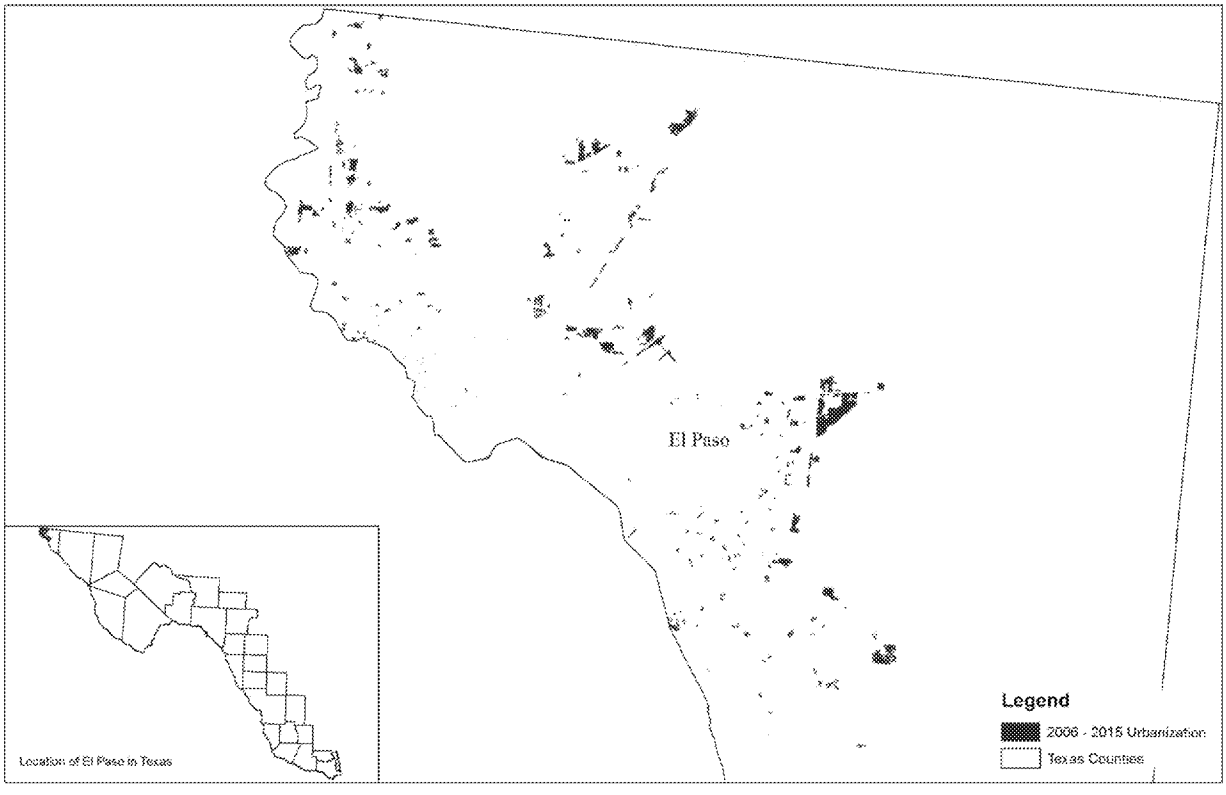
1


McAllen
Harlingen
Brownsville
Location of McAllen, Harlingen, and Brownsville in Texas
Legend
2006 Developed Areas
2015 Developed Areas
Texas Counties

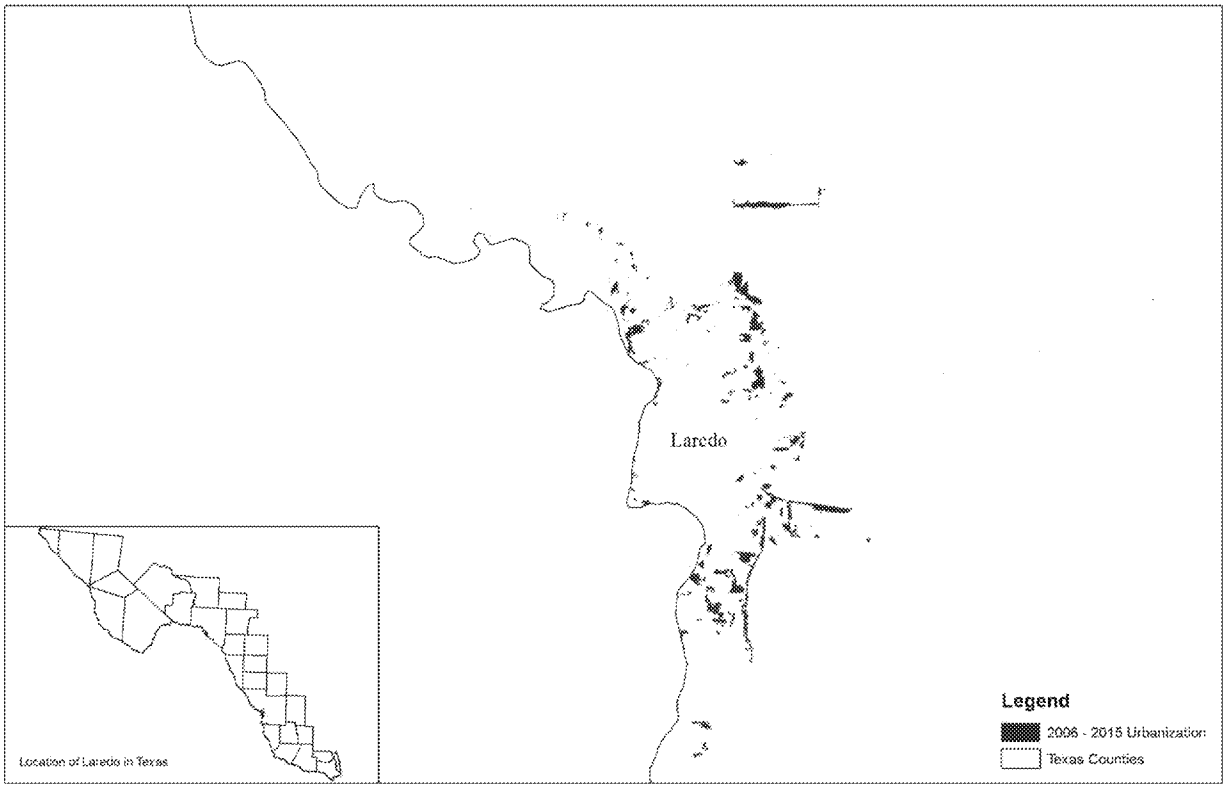
2


Laredo
Location of Laredo in Texas
Legend
2006 Developed Areas
2015 Developed Areas
Texas Counties

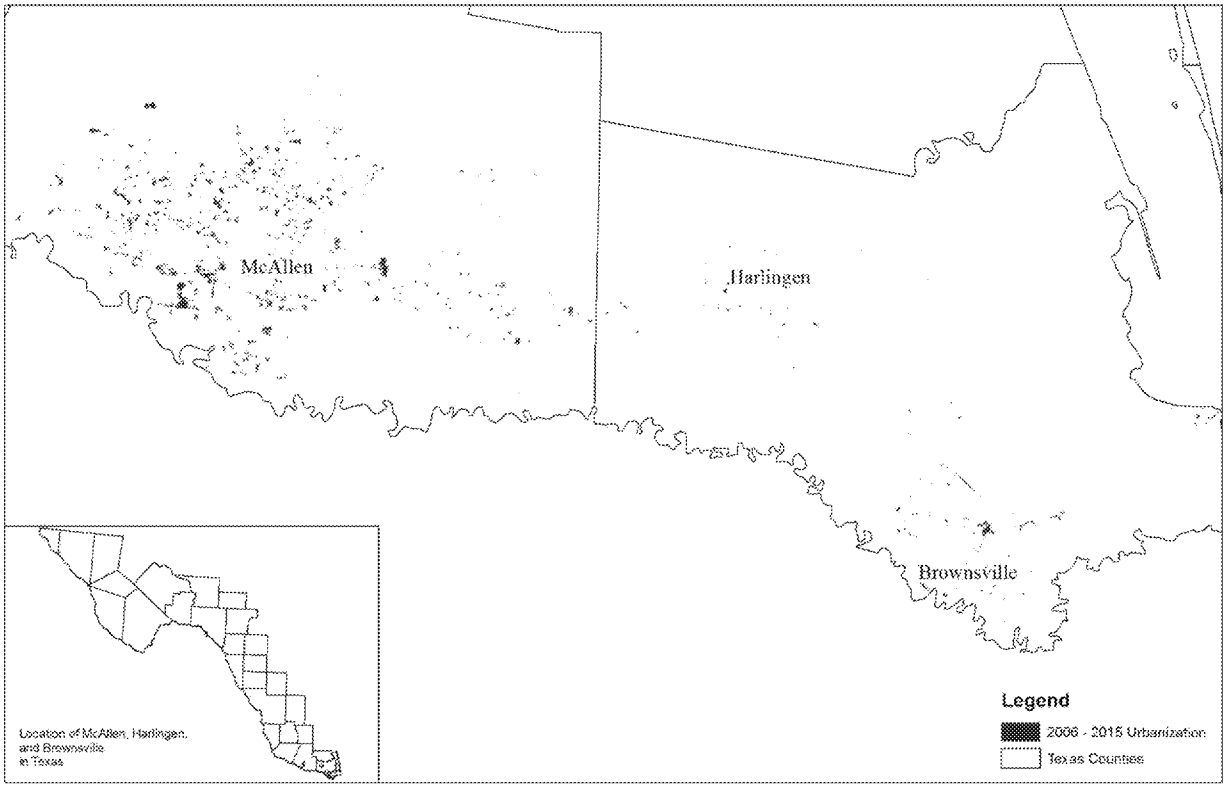
1


El Paso
Location of El Paso in Texas
Legend
2006 - 2015 Urbanization
Texas Counties

2


Laredo
Location of Laredo in Texas
Legend
2006 - 2015 Urbanization
Texas Counties

1


McAllen
Harlingen
Brownsville
Location of McAllen, Harlingen, and Brownsville in Texas
Legend
2006 - 2015 Urbanization
Texas Counties

2
3

4

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Air Risks

Transit, Trade, Travel and Air Pollution

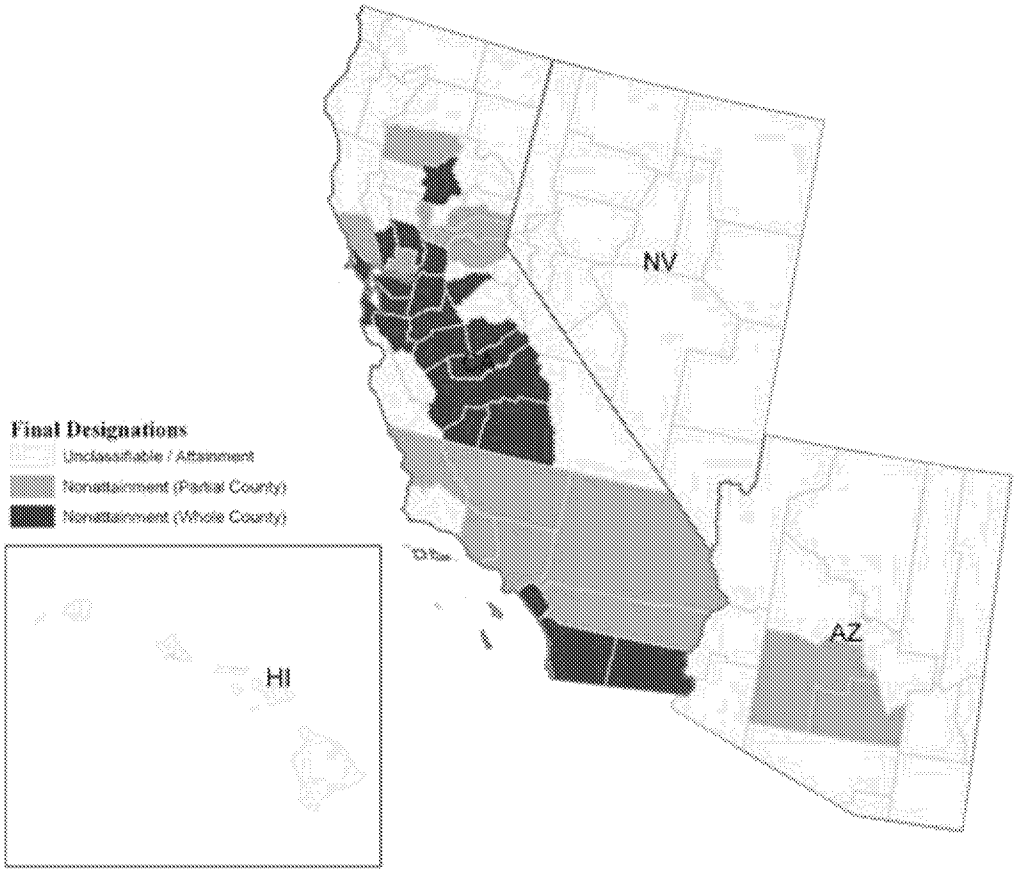
Introduction

The US Environmental Protection Agency, under the Federal Clean Air Act, is charged with oversight on assuring that communities throughout the United States, including the border areas. One of their principle missions is to assure that communities comply with health-based safeguards for certain air pollutants. Called National Ambient Air Quality Standards (NAAQS), these safeguards determine whether or not areas comply with basic standards for particulate matter, ozone, sulfur dioxide, lead, nitrogen oxides and carbon monoxide. The NAAQS are continually reviewed on a five-year cycle, and in general, have become more restrictive through the years, making compliance a challenge for local communities.

While all of these pollutants are impacted by climate and weather, because ozone, composed of three oxygen atoms, is formed by the combination of volatile organic compounds and nitrogen oxide in the presence of sunlight, weather and climate play a key role in the formation of ozone in our urban areas, with ozone levels generally higher during hot, dry summers. Thus, efforts to reduce pollution from transportation, local businesses, power plants, oil and gas production, and other sources of nitrogen oxides and volatile organic compounds will be important in the border areas to allow communities to keep ozone levels down and protect populations, even in the likelihood of hotter, drier summers. In addition, a particular issue confronting border communities is the challenge of controlling pollution in their areas when a significant amount can come from sources within Mexico. Thus, for many years, El Paso has been given special consideration because sources within Mexico contribute to the challenge of meeting compliance with ozone and particulate matter health-based standards.

In 2008, the US EPA set the ozone standard at 75 parts per billion over an eight-hour time period. Under that standard, several communities near the US-Mexico border in Arizona and California do not meet this 2008 standard.

Current Non-Attainment Areas under 2008 Standard



Recently, the US EPA lowered the ozone standard from 75 PPB to 70 PPB. While compliance is based on a three-year average, it is likely that both the current non-attainment areas in California and Arizona and some additional border communities, including El Paso, will have difficulty meeting this standard. Indeed, a preliminary proposal from Texas would declare El Paso in non-attainment for ozone, with final designations due in 2017.

Efforts taken today to reduce air pollution at the local level will help keep border populations healthy, lower ozone levels, allow areas to remain in compliance with EPA standards, and ultimately, allow communities to better face the challenges of hotter, drier climates.

Case Study #1: Border Wait Times:
Lead Author: DOT; Sylvia Grijalva ([HYPERLINK

"mailto:Sylvia.Grijalva@dot.gov"])

1. Border Wait Times Studies (from EPA):

Ports of Entry are a major source of pollution due to the high volume of personal vehicle and diesel truck traffic crossing the border. Reducing carbon monoxide (CO), ozone, volatile organic carbon (VOC) and NOX emissions at the ports is therefore a major priority for EPA's border program. For example, the San Ysidro Port of Entry in San Diego is the busiest land port in the world, accounting for almost 20% of all personal vehicle and pedestrian crossings on the U.S.-Mexico Border. With funding from EPA Region 9, the San Diego Air Pollution Control District installed a $PM_{2.5}$ air quality monitor at the San Ysidro crossing, which will operate for two years, ending January 2017, in order to provide data on the air quality impact to the local community. A report will be issued in the summer of 2017. EPA also collaborates with DHS-CBP, Mexico's Aduanas and the trade community to reduce wait times at ports of entry.

Using a methodology developed by the Federal Highway Administration that estimates emissions from vehicles crossing the ports of entry, EPA has provided funding to estimate emissions at the Calexico (California) and the Mariposa (Arizona) ports of entry. The results of these studies will be used by local, state, and federal agencies responsible for planning new ports or for expansion of existing ports to minimize emissions.

El Paso County and Ciudad Juarez have implemented a mandatory Vehicle Emissions Inspection (VEI) test. Building on results from 23 years of the Ciudad Juarez VEI Program, the State of Chihuahua implemented a similar program state-wide in 2014. Throughout Juarez, Chihuahua and El Paso County, gasoline stations serve oxygenated fuel during colder months and low Reid Vapor Pressure gasoline during the hot summer.

The State of California has promulgated regulations that require diesel trucks and buses operating in California to be upgraded or replaced with air pollution filters beginning in January 2012 to reduce emissions. By January 2015, certain older trucks also had to be replaced. By January 2023, nearly all trucks and buses will need to have 2010 model year engines or equivalent. This regulation applies to all heavy duty diesel-fueled trucks and buses that cross at California ports of entry. California has an active enforcement program at the two commercial ports to ensure compliance with these requirements.

To support emissions reductions from transportation, NADB is financing the Border Wide Transportation Project, which provide loans to public bus companies in Mexico for the purchase of new buses that meet diesel emission requirements. NADB has also provided $205 million in loans to local and state governments in Baja California and Sonora to pave roads, thereby reducing particulate matter emissions. The EPA also works with the Brownsville Metropolitan Planning Organization and Juarez Planning Institute to improve transit mobility by evaluating traffic needs and planning future construction that will mitigate congestion resulting from economic growth (http://mpo.cob.us/projects).

Although not related to mobile sources, the use of fireworks and open burning is a significant

contributor of greenhouse gas and particulate matter during the holiday season in Mexicali. For the past five years, EPA has funded the Imperial County Air Pollution Control District to implement a campaign that discourages such practices through public announcements on local television and distributing outreach materials in schools.

2. **Border Wait Times Studies (provided by DOT Sylvia Grijalva):**
    a. **Commercial Vehicles:**
        i. **Introduction:** Commercial vehicles are often delayed at border crossings. Trip delays increase transportation costs, and impact national security and the environment. *Include statistics on #'s of commercial vehicle crossings, average wait times, environmental impact, and economic impact.*
        ii. **What's being done:** There are efforts underway by several agencies to improve processes (inspection, queuing, just-in-time delivery) as well as programs to fund and improve infrastructure at ports of entry (POEs) to reduce delays and increase security. The objective of these studies is to provide a baseline of border crossing delay by measuring border crossing times for commercial trucks at each of the border crossings. These baseline data will then be used to help measure the success of improvement projects and strategies.
        iii. **Goal: The goal is to have 95% of commercial truck traffic included in the monitoring and near real-time dissemination of border wait times and cross-border wait times along entire U.S. - Mexico border.** Ongoing sites include: Mariposa (Nogales, AZ/Nogales, Sonora); Bridge of the Americas (BOTA) (El Paso, TX/Juárez, Chihuahua); Ysleta/Zaragoza (El Paso, TX/Juárez, Chihuahua); Pharr (Pharr, TX/Reynosa, Tamaulipas); World Trade Bridge (Laredo, TX/Nuevo Laredo, Tamaulipas); Laredo Colombia Solidarity Bridge (Laredo, TX/Colombia, Nuevo León); Veterans Memorial Bridge (Brownsville, TX/Matamoros, Tamaulipas); Camino Real International Bridge (Eagle Pass, TX/Piedras Negras, Coahuila). Please see website [HYPERLINK "https://www.fhwa.dot.gov/exit.cfm?link=http://bcis.tamu.edu/"]. *Note: Connect this monitoring efforts to improving overall air quality. Clearly connect the dots of how monitoring results in benefits.*
    b. **Private Vehicles:**
        i. **Introduction:** *Provide an introduction for how private vehicles are impacted by border wait times.*
        ii. **What is being done:** A privately owned vehicle (POV) traffic border wait times system has been implemented at Ysleta/Zaragoza in both directions (southbound and northbound). (Please see website [HYPERLINK "https://www.fhwa.dot.gov/exit.cfm?link=http://bcis.tamu.edu/"]. Penetration rates of Bluetooth-enabled devices are being conducted for both southbound and northbound POV traffic in order to determine if a Bluetooth border wait time system is viable. Bluetooth penetration tests have been concluded statistically verified to be eligible for implementation at seven locations: Juárez-Lincoln Bridge (Laredo, TX/Nuevo Laredo, TX);

McAllen-Hidalgo-Reynosa Bridge (McAllen, TX/Reynosa, TX); Paso del Norte Bridge (El Paso, TX/Ciudad Juárez, Chihuahua); Pharr-Reynosa International Bridge on the Rise (Pharr, TX/Reynosa, Tamaulipas); Brownsville & Matamoros International Bridge (Brownsville, TX/Matamoros, Tamaulipas); Del Rio-Ciudad Acuña International Bridge (Del Rio, TX/Acuña, Coahuila); and Gateway International Bridge (Brownsville, TX/Matamoros, Tamaulipas). The Paso del Norte Bridge and Stanton Bridge POEs (El Paso, Texas/Ciudad Juárez) will be implemented with Bluetooth technology in both directions.

Bluetooth penetrations tests are being conducted five locations for POV traffic: Bridge of the Americas-Córdova (El Paso, TX/Ciudad Juárez, Chihuahua); Veterans International Bridge (Brownsville, TX/Matamoros, Tamaulipas); Gateway to the Americas (Laredo, TX/Nuevo Laredo, Tamaulipas); Eagle Pass Bridge 1 (Eagle Pass, TX/Piedras Negras, Coahuila); and Camino Real International Bridge (Eagle Pass, TX/Piedras Negras, Coahuila).

Bluetooth and/or Wi-Fi penetration tests are to be conducted at six POE locations along the AZ-Sonora border: Naco (Naco, AZ/Naco, Sonora); San Luis I (San Luis, AZ/San Luis Colorado, Sonora); Mariposa (Nogales, AZ/Nogales, Sonora); Deconcini (Nogales, AZ/Nogales, Sonora); Lukeville-Sonoyta (Lukeville, AZ/Sonoyta, Sonora); and Douglas-Agua Prieta (Douglas, AZ/Agua Prieta, Sonora). Implementation of technology in both directions will follow at all locations that meet statistical penetration standards. At San Luis I in AZ, pedestrian and bicycle border wait times will also be documented.

California and Baja California are taking a regional system-wide approach from the San Ysidro POE to the Tecate POE in determining border wait times. They have begun work on implementing a Bluetooth and/or Wi-Fi monitoring system.

The Santa Teresa-San Geronimo POE (Santa Teresa, NM/San Geronimo, Chihuahua) will be implemented with a commercial vehicle border wait time system.

iii. **Goal:** Is there a goal for POVs similar to that for commercial vehicles above?

c. **Pedestrian Traffic:**

i. **Introduction:** *What are the impacts to pedestrian traffic? Does increased wait times for pedestrian crossers result in additional vehicular traffic? Is there a need to include a pedestrians in this section?*

ii. **San Luis and San Luis Rio Colorado Pedestrian and Bicycle Access Study:** The study would evaluate the existing conditions and assess the needs for pedestrian and bicycle border crossing access based on the existing data availability from previous and current studies, as well as new

information conducted through this study. The existing conditions report and analysis will identify existing transportation and transit infrastructure conditions, demand for transit pedestrian and bicycle services, and evaluate possible impacts to non-motorized circulation resulting from possible improvements at the Port of Entry I. A travel behavior analysis will be conducted of cross-border pedestrian and bicycle travel to provide a better understanding of the mode of transportation and necessities at the POE. The study would further provide concept plans based on past studies and current demands that illustrate improvements to the circulation of pedestrians, bicycles, and transit services and/or facilities to benefit the overall transportation network and foster public health for residents of this border community. Preliminary concepts will include pedestrians and bicycle access at the POE, including, but not limited to facility needs assessments, pedestrian separation elements, pedestrian comfort stations, signs, water fountains, shades, sidewalks, welcome signs, and other non-motorized improvements. A financial element strategy will be included in order to estimate the cost of improvements and possible revenue sources to implement improvements. Overall, the study will provide recommended improvements and policies that can be implemented in order to provide a safer, easier and more comfortable border experience for pedestrians and bicyclists. This will be 12-month study.

3. **Data Analysis and Use:**
   a. **Current:** Joint Working Committee (JWC) for Transportation Planning will analyze various ways that border wait time data can be used for planning, operations, traffic information, and design, and what methods format are needed for dissemination of the information. Most of the information is now being collected through the Border Crossing Information System (BCIS) and being disseminated at the following website: [HYPERLINK "https://www.fhwa.dot.gov/exit.cfm?link=http://bcis.tamu.edu/"]. This system includes near real-time and archived data for commercial and POV traffic.
   b. **Regional Border Master Plans**: JWC has created a compendium of border-wide regional master plans with a comprehensive and prioritized assessment of transportation needs along the border, including at the POEs. The Regional Border Master Plan (BMP) provides the next logical step in a comprehensive, binational transportation planning process. The BMP includes land use, environment, population, and socio-economic data. This data is used to adequately evaluate growth and future capacity needs at the border and to more realistically forecast future conditions in the border region. Additionally, this data can be utilized to evaluate the existing binational transportation and POE system, its current and future demand, and the infrastructure necessary to handle the expected growth. The BMP fosters consistency amongst the individual agency planning processes, which creates a documentation that feeds back into the periodic updates of plan. The BMP considers short-term, mid-term, and long-term needs. The comprehensive list and prioritized assessment of the transportation and POE needs support international trade as well as improve cross-border travel and the quality of life for the residents of and visitors to each region. Therefore, BMPs can be incorporated

as a component of Federal, State, and local strategic plans. Additionally, the outcome of the BMP process should be accepted and embraced by stakeholders throughout the border region. Stakeholders should make the BMP part of their overall planning and forecasting process. BMPs should be regularly updated (every 3-5 years) with new data, policy issues, and economic and infrastructure changes as planned by the stakeholders. As of October 2015, BMPs have been completed for 5 regions: California-Baja California (2008 and 2014 update); Arizona-Sonora (2013); West Texas-New Mexico/Chihuahua (2013), Lower Rio Grande Valley-Tamaulipas (2013); Laredo District in Texas-Tamaulipas/Nuevo León/Coahuila (2012). The BMP for New Mexico-Chihuahua is in progress.

i. **Include:** *Please include background on the JWC and identified the appropriate parties participating in this effort.*

c. **Transportation Modeling:** In an effort to provide accurate short-, medium-, and long-term traffic projections for cross-border travel, cross-border and POE travel demand forecast modeling are desired, including information to populate travel demand models. Current examples of this include the AZ-Sonora Binational Travel Demand Model Phase I and a project in California-Baja California. JWC will support the completion of the Scenario Planning of Future Freight and Passenger Traffic Flows across the U.S. - Mexico and U.S. - Canada Borders project. This project will model traffic and produce projections through the year 2045. JWC support will help guide the modeling effort and the project's success. These projections will provide additional tools for future Border Master Plan updates.

4. **State efforts**

a. **California Integrated Border Approach Study:** The California Integrated Border Approach Study (CA-IBAS) is an estimated 2-plus year study aimed at exploring an innovative multi-agency integrated border systems-based approach to project delivery strategies at the California-Mexico border. This research effort aims to provide advice to address solutions related to multi-agency planning and innovative project delivery to overcome funding shortages and individual agency limitations to improve multimodal regional mobility at communities abutting the State's international border with Mexico. While there are a number of Federal, State, and local agencies that work in border communities, there are no formalized, collaborative strategies to implement projects that go "beyond the mandate" of individual agencies. The California border region needs a multi-institutional border mechanism capable to serve as the lead coordinating entity for strategic planning, project delivery, and funding partnerships to address regional mobility needs at California's border communities. CA-IBAS seeks to propose this mechanism. The CA-IBAS has been divided in two phases. Phase 1 documented the state of the practice for improving mobility and the traveler experience in California communities adjacent to California/Mexico land POEs. It provided an overview of agencies involved in mobility and security issues surrounding California's border communities, and of institutional structures that might be used to improve service delivery and funding, as well as financing options to support those institutional structures and multi-agency projects. It also summarized case studies of selected best practices from other border regions. Phase 2 of this Study builds upon the outcomes and findings from Phase 1.

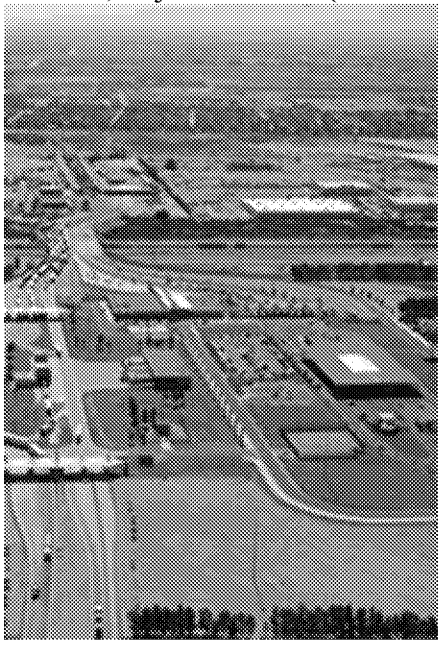
CA-IBAS Study will:

- Describe the existing mobility conditions and challenges at each of California's border communities abutting international land POEs.
- Propose to the State of California different alternatives of intra-agency collaboration to serve California's international border with Mexico.
- Propose the required legal operating frameworks for a future intra-agency structure.
- Develop innovative joint mechanisms for planning, funding, financing, and project delivery at California's border communities.
- Provide a 5-year concept of operations for a new intra-agency border collaboration mechanism.

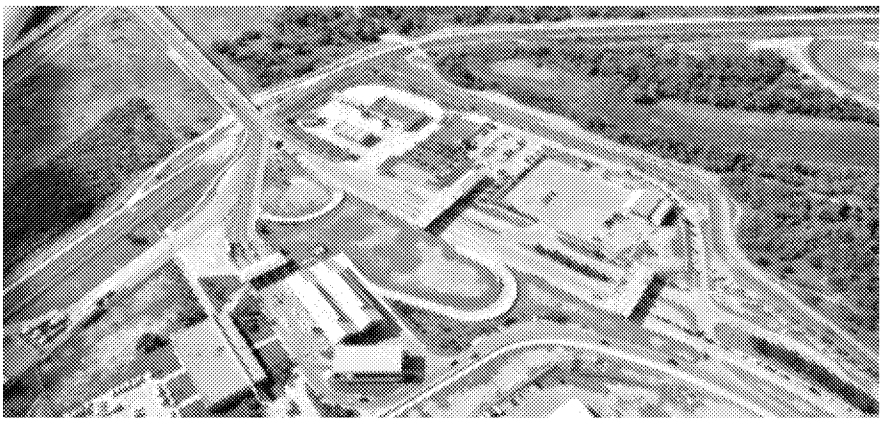
b. **Southern Arizona to Central Mexico Freight Corridor Study and Needs Analysis**: This study will focus upon Interstate 19 from Tucson to Nogales, Arizona and Carretera Federal 15 from Nogales, Sonora to central Mexico. The goal of the analysis is to identify ways by which Arizona's transportation entities (State DOT, county DOTs, and regional planning agencies) may leverage performance improvements or the creation of new freight movement capacity within the State's transportation network to garner economic development benefits. Modes analyzed will include both commercial motor carrier and freight rail. The corridor of interest spans from Tucson, Arizona, along Interstate 19 to Nogales, Arizona and Nogales, Sonora, before extending southward along Carretera Federal 15 to Guaymas, Mazatlán, Guadalajara, and eventually Mexico City. The primary aim of the study is to determine the deficiencies of the transportation network on Carretera Federal 15 and Interstate 19 from Central Mexico to Tucson, Arizona.

5. Photos/References

a. Calexico East: Calexico East Port of Entry between Calexico, California and Mexicali, Baja California (Source: FHWA)



b. **Veteran's Memorial Bridge:** Veteran's Memorial Bridge, Brownsville, TX



c. **Website:** [HYPERLINK "http://bcis.tamu.edu/en-US/index.html"]

Use two fingers to move the map

[HYPERLINK "http://www.fhwa.dot.gov/privacy.cfm"] | [HYPERLINK "http://www.fhwa.dot.gov/foia/"] | [HYPERLINK "http://www.fhwa.dot.gov/accessibility/"] | [HYPERLINK "http://www.fhwa.dot.gov/webpolicies/publishschedule.cfm"] | | o[HYPERLINK "http://www.oig.dot.gov/Hotline"]
[HYPERLINK "http://www.usa.gov/"] | [HYPERLINK "http://www.whitehouse.gov/"]

Case Study #2: Promoting Renewable Energy in Border Communities
Lead Author: EPA

1. **Background: (Provided by EPA)** EPA's *RE-Powering America's Land* Initiative encourages renewable energy development on previously contaminated properties, such as landfills, mines, and industrial developments. In addition to maintaining an inventory of these properties, the EPA and DOE's National Renewable Energy Laboratory (NREL) collaborate to conduct feasibility studies for selected properties, examining both technical remediation of the site, as well as an economic assessment.

   There are currently 13 landfill methane capture projects and three more either planned or under construction along the border, where landfill gas is used for power generation on-site or transferred to off-site industrial users. Most of these projects are located in California or Arizona.

2. **Deming, NM:** The Peru Mill Industrial Park, a former mining site in southern New Mexico, near Deming, has been extensively analyzed for solar energy generation capacity, and deemed suitable for a large-scale photovoltaic (PV) system of up to 36.4

megawatts (MW).

EPA has identified several benefits to siting PV systems at Deming and other Brownfield sites. In addition to mitigating climate change by reducing greenhouse gas emissions, solar power generation can be developed in place of limited greenfields, preserving the land carbon sink, especially since these sites are often located near existing roads, and energy transmission or distribution infrastructure. This advances cleaner and more cost-effective energy technologies while building community resiliency.

(Reference: Feasibility Study of Economics and Performance of Solar Photovoltaics at the Peru Mill Industrial Park in the City of Deming, New Mexico Kosol Kiatreungwattana, Jesse Geiger, Victoria Healey, and Gail Mosey. Produced under direction of the U.S. Environmental Protection Agency (EPA) by the National Renewable Energy Laboratory (NREL) under Interagency Agreement IAG-08-0719 and Task No. WFD3.1001. Technical Report NREL/TP-7A30-58368, April 2013.

3. **Private Partners:**
    a. **North American Development Bank (NADB):** has provided loans that finance almost a half-billion dollars for nine solar and wind projects within Arizona and California. This represents about 271 MW generated. (*Need Source*)
    b. **Border Environment Cooperation Commission (BECC):** facilitated the Baja California Climate Change Action Planning process, which resulted in an estimate of costs and benefits of different mitigation and adaptation options.
    c. **BECC info (Summarized by EPA)**

BECC has supported border efforts to address air risks posed by climate change. For example, under a collaboration between BECC, the EPA, the Center for Climate Strategies (CSS) and Mexico's National Institute of Ecology and Climate Change (INECC), six Mexican Border States developed greenhouse gas emissions inventories and forecasts in 2010. The inventories determined that by 2025, the six states would generate 31% of Mexico's total GHG emissions with only 19% of the population. Following the completion of those inventories, BECC, with support from Border 2020 USAID, LACRI and COLEF, continued work with the Mexican States of Baja California, Sonora, Chihuahua, Coahuila and Tamaulipas to complete state climate action plans (SCAPs), which identified mitigation policies and the economic impacts of implementing these public policies. In Baja California, Coahuila, and Chihuahua, the SCAP's also includes socio-economic micro and macro analysis of mitigation policies, as well as the quantification of reduction and costs, and the cost savings of the Greenhouse Gases Inventory.

Phase 1 of developing the SCAPs identified the potential state climate action policies and processes, including GHG inventories and emissions projections, reducing emissions, and climate adaptation strategies. Phase 1 also established an Advisory Group and technical workgroups. The policies proposed in Phase 1 were then further analyzed and implemented for each state through Phase 2 of the CAP process, which

involved a detailed cost-benefit analysis for each State. [HYPERLINK "http://www.climatestrategies.us/international_actions/international_actions/view/1"])

In 2013, Phase 2 was begun for Baja and Coahuila. Phase 2 was a partnership between BECC, Secretaria de Medio Ambiente, US AID's Mexico Low Emission Development Program, and CSS. The policies Phase 2 focused on five sectors: Energy supply; residential, commercial, Institutional and Industry; transportation and land use; agriculture, forestry and other land use; and waste management. Each proposed policy was reviewed to determine annual reductions in greenhouse emissions and the cost effectiveness within each respective state. The reductions were analyzed against the baseline forecast of greenhouse gas emissions using the Center for Climate Strategies June 2010 reports developed for each state.

The macro-economic analysis showed the recommended policies that were identified to lower greenhouse gases have, as a group, a positive impact on the economy through increases in employment and gross domestic product. There is also a great disparity amongst the individual policies. For example, in Baja California, Finance Incentives for Machinery Energy Efficiency showed the greatest economic gain in the analyses based on the reduction of production costs and the economic stimulus from the investment in new equipment and machinery. Energy Supply Diversification is seen to have the highest negative impact in Baja California because of high capital costs of the generation of renewable energy. Future initiatives may include review 4 of the 17 policies in the Coahuila CAP to identify implementation strategies.

References:

Final Report of the Baja California Phase 2 Climate Action Plan (December 2014). Center for Climate Strategies

Final Report of the Coahuila Phase 2 State Climate Action Plan (January 2016). Center for Climate Strategies

Plan Estatal de Accion ante el Cambio Climatico del Estado de Sonora: Fase 1 (Agosto 2011). Comision de Ecologia y Desarrollo Sustentable (CEDES).

4. **Goals:**
    a. Under Border 2020, Goal 1 is to reduce air pollution. This is being accomplished through initiatives to boost energy efficiency and renewables, including 20 renewable energy projects supported by BECC/NADB and under a two-year plan to increase air monitoring along the border. Several air quality monitoring projects are currently underway, including particulate matter monitors at two sites in Mexicali, and at the San Ysidro Port of Entry in San Diego, which will aide in understanding PM2.5 transport through the Valley.

Case Study #3: Investing in Green Infrastructure at San Ysidro
Lead Author: GSA; ???

1. **Background:** (provided by DOT Sylvia Grijalva from GSA Fact Sheet)
The San Ysidro Land Port of Entry (LPOE) is the busiest land border crossing in the Western Hemisphere; currently processing an average of 50,000 northbound vehicles and 25,000 northbound pedestrians per day. The San Diego Association of Governments (SANDAG) projects an 87% increase in vehicle traffic in San Ysidro by the year 2030.

2. **Project Overview:** To accommodate that growth and to better meet the changing needs of the tenant agencies and the traveling public, GSA is conducting a complete reconfiguration and expansion of the port. The scope includes the demolition and construction of the LPOE, including primary and secondary inspection areas, administration and pedestrian buildings, and all other support structures. The project will expand pedestrian processing facilities including a new pedestrian crossing on the east side of the LPOE that will connect with a new multimodal transportation hub in Mexico and expanded northbound inspection facilities. Additionally, there will be a new north and southbound crossing at El Chaparral/Virginia Avenue with an associated transit center.

   Once all three phases are complete, the new port will boast 62 northbound vehicle primary inspection booths, one dedicated bus lane and inspection booth spread over 34 lanes, as well as improved processing facilities for bus and Secure Electronic Network for Travelers Rapid Inspection (SENTRI) travelers. The LPOE will have over 110,000 square feet of new primary and secondary vehicle inspection canopy utilizing state-of-the-art materials that will both conserve and produce energy. In addition, a portion of the Interstate 5 South freeway will be realigned and expanded from the current five lanes to ten lanes which will connect to Mexico's new El Chaparral facility. Corresponding southbound inspection canopy will be constructed to support Customs and Border Protection's (CBP) southbound vehicle inspection efforts.

   In designing the new San Ysidro LPOE, GSA is committed to build the "Port of the Future" and strives to build a facility that is sustainable, operationally scalable, and will dramatically reduce the Port's carbon footprint, while at the same time enhancing CBP's ability to conduct their mission. With the innovative applications of energy production projects, as well as sustainable energy and water-saving features, the San Ysidro LPOE aspires to receive the Leadership in Energy and Environmental Design (LEED) Gold certification.

   GSA is currently collaborating with local agencies to develop a plan for improvements at

Virginia Avenue to support northbound and southbound pedestrian crossing on the west side of the port. The proposed design includes ten northbound and two reversible pedestrian processing lanes and conveniently serves the traveling public on the west side of San Ysidro. The concept includes an intermodal transit center for buses and taxis in addition to a pedestrian drop off and pickup area. Furthermore, with the passage of the Fiscal Year 2015 Consolidated and Further Continuing Appropriations Act, the $216 million needed for

3. **Sustainability Goals**
    a. **Energy:**
        i. Solar photovoltaic system
        ii. Solar thermal hot water system
        iii. Geothermal heat exchange system
    b. **Water**
        i. Ultra-low flow fixtures
        ii. Rainwater retention and reuse system
        iii. Onsite waste water treatment system
        iv. Xeriscape landscaping (drought tolerant plants

4. ***Recommendation***: *While this project is a model for sustainable features, it will be important to emphasize* ***how*** *these features directly benefit* ***air quality*** *in the region.*

Case Study #3: Creating Resilient Communities
Lead Author:

Creating Resilient Communities through Energy Efficiency, Onsite Renewable and Storage

Communities throughout the border are creating more climate-resilient communities with local renewable, energy efficiency and demand response programs. In some cases, these are local or state initiatives, but the federal government has played and can play a role through the Department of Energy, Border Environmental Cooperation Commission, North American Development Bank, Environmental Protection Agency, Federal Energy Regulatory Commission among other federal agencies. With expected changes in our weather and climate, indicating more extreme weather, having a resilient energy system that can operate efficiently and encourage local generation will be important to border communities. At the same time, many of these solutions also reduce the need to run larger central power stations or natural-gas peakers that can impact air quality.

Making New Buildings More Efficient

Cities and states along the US-Mexico border have different "codes" or standards related to the use and consumption within both residential and commercial buildings.

Thus, Texas, New Mexico and California do set minimum energy codes with which all builders are required to comply, though actual implementation and enforcement is left up to local municipalities.

In Texas, since 2001, the State Energy Conservation Office, a state department within the Texas Comptroller of Public Accounts, has required that more energy efficient codes be adopted. Most recently, following the passage of HB 1736, SECO adopted the 2015 International Energy Conservation Code -- or its equivalent -- for all state-funded buildings, as well as residential and commercial construction, beginning in 2016 (See Table). Cities throughout Texas are now required to implement these new codes for new construction, though local amendments are allowed. In Cities considered to lie in a non-attainment or near non-attainment area because of concerns of ground-level ozone -- such as El Paso -- cities can only make the minimum codes more energy efficient not less. El Paso is currently going through the process to adopt the 2015 IECC from their current code, which is based on the 2009 IECC.

Independent analysis by the Texas Energy Systems Laboratory have shown that the average home built to the 2015 IECC will save between nine and 20 percent energy depending upon the climate zone and size of the home. (Get Footnote).

In California, the state also mandates minimum building code standards for new construction, which are continually updated through a rulemaking process. The California Building Codes can be found in Title 24 and are generally among the most energy efficient in the nation. In fact, they are the only state to require compliance with a "Green Construction Standard." Recently, California approved the new 2016 Energy Efficient Standards, which build on the previous standards and the 2015 IECC and will become effective on January 1, 2017, In addition to requiring that new homes and buildings be energy efficient with better windows, insulation, duct leakage, and roofs, the California requirements also under Title 24 require all buildings - with some exceptions -- to be "solar-ready," that is easy to add solar panels do if future occupants want.

Thus, some communities like San Diego already require new homes and businesses to be solar-ready which helps spur the adoption of solar technology.

In New Mexico, there is currently not a process in place to adopt the 2015 IECC, although since January 1, 2012 builders are required to comply with the 2009 IECC. A state agency, the [HYPERLINK "http://www.rld.state.nm.us/construction/general-building.aspx"], is the department charged with analyzing and adopting new version of the code.

In Arizona, there is no state minimum code, though individual cities have for the most part adopted either the 2009 or 2012 IECC.

While the federal government does not play a direct role in energy code adoption or enforcement along the border or in states in general, the Department of Energy is a participant in the development of the codes through the International Code Council and other groups like ASHREA. In addition, DOE analyzes codes through its national laboratories, and provides resources and training for states on building sciences and building code compliance. Thus, DOE will analyze the latest codes to assure that they will lead to more energy efficient homes and buildings.

IN addition, because the DOE provides grant funding to states for energy planning and other

activities, that funding is contingent upon states showing compliance with certain energy efficient building code measures, including having considered and adopted more recent energy codes. Thus, in order to certify compliance with Title III of the Energy Conservation and Production Act (ECPA), states must provide evidence that they have adopted or have begun a process to adopt the latest IECC code and are actually enforcing or assuring compliance with that code.

DOE can also work on its own code should it believe that the most recent version of the IECC does not make new buildings more efficient.

Making existing buildings more efficient

Many local utilities, states and local governments provide funding, incentives or programs designed to make existing buildings more efficient. Again all of the border states have provisions to require utilities to run programs that meet part of their energy demand through energy efficiency and demand response programs.

In Texas, all investor-owned utilities that own poles and wires must collect a fee and run energy efficiency and demand response programs that meet at least 0.4 percent of their peak demand. Thus, in South Texas, AEP South provides such programs, including weatherization for low-income Texans, while in El Paso, EL Paso Electric has a variety of programs designed to reduce energy use and peak demand. EPE also runs programs in their service territory in New Mexico under different rules.

New Mexico requires a greater energy efficiency goal for utilities. PUT IN DETAILS HERE

California has similar, but more aggressive energy efficiency goals for its utilities and all utilities are required to meet..

Give some examples..

Many border Texans live in areas served by municipal utilities or rural electric cooperatives, which do not have to meet the minimum energy efficiency goals of the Investor-Owned Utilities. However, these municipal and electric cooperatives often do have their own programs as part of their policies and are required to report their programs to the State Energy Conservation Office under Texas law. Information on these municipal and electric cooperative programs can be found at SECO's website at [HYPERLINK "http://www.seco.cpa.state.tx.us/energy-reporting/public-power-reports.php"].

A more recent effort was aimed at getting cities in Texas to replace old traffic lighting with modern LED lighting, saving cities money on traffic lighting upkeep and lowering energy bills.

Energy Efficient and Renewable Energy Financing

In addition to these programs run by utilities, the State Energy Conservation Office provides grants and loans to public entities that pursue renewable energy and energy efficient retrofits to

homes and businesses. While there are a variety of programs, the longest running is known as LOAN STAR, a pot of money which provides low-interest loans to schools, and local government, with the energy savings flowing to pay back the loans.

PUT IN DATA ABOUT THE PROGRAM.

Recently, many states, including both Texas and California, have passed statewide legislation that authorizes the creation of Property Assessed Clean Energy Districts. PACE Districts are entities that can assess a loan on a property for energy efficiency, water conservation or renewable energy improvements, and then allow the loan to be paid back through the property taxes, by adding a special fee that is paid back over time. In this way, energy efficiency and renewable energy can be financed.

While California, New Mexico and Texas have passed legislation allowing PACE Districts to be created in local districts, issues have arisen specifically for the use of PACE for residential property. Thus, Texas and New Mexico at the moment have only moved forward on commercial PACE program, while California continues to allow both residential and commercial PACE programs. In 2010, the Federal Housing Finance Agency expressed concerns about how residential PACE programs would impact federally-backed mortgages and FHFA directed the two largest government-backed mortgage lenders, Fannie Mae and Freddie Mac, to stop underwriting mortgages for homeowners who were participating in the program. Because PACE loans take priority if a homeowner defaults or moves, federal regulators worried they would ultimately hurt Fannie and Freddie.

Texas has not proceeded with any residential PACE programs because of this issue, but some communities, including Willacy County on the border, Houston, Dallas and Travis County, have all begun commercial programs. In California, they have added safeguards to PACE loans and have proceeded and expanded residential PACE.

In the meantime, FHFA is considering new rules and guidelines that may allow residential PACE to move forward (GET MORE INFO). The federal government has a unique role to play in promoting PACE, and currently, the Federal Housing Finance Agency is conducting rulemaking to see how to allow residential PACE to proceed while protecting the agency and the federal mortgage market.

In addition to the efforts by FHFA to clarify the rules for residential PACE, recently the Border Environment Cooperation Commission and the North American Development Bank began review of a proposed border-wide PACE program. Under the proposal, NADBANK would lend $60 million to a third-party to run a border program in any border counties where PACE is authorized. If approved, such a concept could spur additional renewable, water conservation and energy efficiency projects, helping reduce air pollution and make border communities more resilient.

In addition to PACE, some utilities, municipal utilities or electric cooperatives have offered

either "on-bill repayment" or "on-bill financing" which would allow residential and commercial customers to borrow money for local storage, solar and energy efficiency projects and pay them back over time. Recently, in Texas, Pedernales Electric Cooperative began offering such loans through its billing systems, utilizing start-up funding obtained from the US Department of Agriculture's Rural Utilities Service.

The USDA can be an important source of funding for electric cooperatives along the border help make border communities more resilient through investments in energy efficiency, renewables and storage.

Onsite Renewable Systems

While several utilities along the border have programs to encourage onsite renewable technology, only California has a statewide rebate for onsite solar development (Give information here) as part of their overall effort to reach at least 50% renewable by 2030.

In Texas, there is no statewide goal or rebate for onsite solar systems, but many utilities, including El Paso Electric and American Electric Power, have offered rebates to homeowners wishing to add solar. Such systems help reduce energy use in residential and businesses and can also help provide peak power back to the energy grid.

Rules differ widely among states and utilities over how customers who inject power back into the system are compensated, from Texas, where it is essentially up to each retail electric provider or utility to develop those rules, to California, where "net-metering" paying the actual retail rate is required (up to a certain threshold).

Energy Storage Solutions

A more recent development has been the growth in the use of energy storage as a solution to create a more resilient and flexible electric grid. 2015 represented the largest growth in energy storage technology in the US (put in some data).

Energy storage technologies -- including batteries, flywheels, compressed air energy storage, thermal storage like chilling stations and hydrological storage systems -- are unique in that they take electricity generated at another site, store the energy and then release it a later time.

Many electricity markets, electric consumers and utilities are considering how to incorporate energy storage into our mix of energy resources. In California, under , all large investor-owned utilites are required to meet goals to purchase energy storage technology. In the most recent purchases.,

In Texas, there is no requirement to add electric storage, but new rules are being developed on how storage can participate in electric and operating reserve markets. Recently, several large-scale battery projects have been developed, and are mainly providing "ancillary" services.

Along the border, AEP, a large private electric company, added a large battery of 4 MWs to its

transmission system as a back-up power source at the end of a large transmission line near Presidio.

Thus, energy storage can play an important role in integrating more renewables - which by their nature are not dispatchable and are variable in their power output, and as a reliability tool in transmission and distribution electric systems. With the increase in renewables, and more extreme technologies, batteries and other storage technologies are a useful tool to make communities more resilient.

The federal government does play a role in the development of storage technology. First, through their Energy Laboratories, DOE provides important funding and research for the integration of storage technology. Secondly, DOE provides direct funding to utilities and others. Third, the Federal Electric Regulatory Commission has opened up a comment period under Docket No. AD16-20-000 for the public to give input on how storage technology can be more seamlessly integrated into markets and transmission systems.

OTHER OPTIONS:

1. Provided by EPA:
    a. **Energy Efficiency in Homes/Schools:** Several border communities have demonstrated the value of solar panels to promote energy efficiency at private and public facilities. At the Columbus, New Mexico – Palomas, Chihuahua US-Mexico Port of Entry, solar panels power the servicing facilities on the US side. Presidio, Texas schools have also installed solar panels. And in January 2016, CANACINTRA, Mexico's national chamber of manufacturing industries, and the Joint Advisory Committee's industry partner, inaugurated a solar panel to promote within Mexico.
    b. **Waste-to-Energy Technologies:** Under EPA's Border 2020, the Texas-New Mexico-Chihuahua Regional Workgroup Joint Advisory Committee partner, Cementos de Chihuahua in Juarez, has been using over 1.2 million scrap used tires annually for energy co-generation. Recently the Cementos de Chihuahua submitted and received authorization from Mexico's Ministry of Environment (SEMARNAT) for utilizing non-hazardous municipal waste that cannot be recycled as a source of energy to complement the co-generation from the Juarez Cement Plant. They will have the capacity to process 100 M tons daily.

       EPA Region 6 has conducted several energy management workshops for water and wastewater utilities along the U.S. – Mexico border to promote a reduction in energy consumption and costs by using the ISO 50,001 Energy Management Systems framework and EPA's Energy Star Guidelines for Energy Management. However, utilities along the border have not yet adopted these energy management practices, usually because they require an initial monetary investment. [Write-up from Reazin email of 3/22/16)

2. Provided by EPA Region 9:
    a. **Bus Modernization:** The North American Development Bank is financing the Border Wide Transportation Project, which provide loans to public bus

companies in Mexico for the purchase of new buses that meet Mexico's newest diesel emission requirements.

b. **Road Pavement:** The North American Development Bank has provided $205 million in loans to local and state governments in Baja California and Sonora to pave roads which reduces particulate matter emissions.

c. **Fireworks:** Although not related to mobile sources, the use of fireworks and open burning is a source of greenhouse gas and particulate matter emissions during the holiday season in Mexicali. For the past five years, Region 9 has provided funding to the Imperial County Air Pollution Control District to implement a campaign to discourage such practices by airing public service announcements on local television and distributing outreach materials to local schools.

d. **State of California Climate Change Program**. The State of California has been a leader in reducing GHG emissions from energy production. The State has a Renewable Portfolio Standard goal that, by 2030, 50% of all electricity consumed in the state will be generated from renewables. In 2014, the State was at the half-way point. The State also has implemented programs to encourage the installation of photo-voltaic on residential and commercial properties and the purchase of electric vehicles. If you would like more detailed information please let me know.

e. **Annual outreach campaign in Mexicali**. Every Christmas season, the Imperial County Air Pollution Control District implements an outreach program, including airing commercials on local television in Mexicali to discourage the use of fireworks and open-burning, both of which are sources of NO_x and Particulate Matter impacting Imperial County.

f. **Smog-check program in Baja California**. In 2014, the State of Baja California initiated a state-wide smog check program for all personally owned vehicles.

g. **$PM_{2.5}$ Monitoring in Mexicali**. With funding from EPA, the California Air Resources Board is operating two PM2.5 monitors in Mexicali for the next two years. Air quality from these monitors will help inform both countries of the international transport of $PM_{2.5}$. (Imperial County is in non-attainment for $PM_{2.5}$and has been successful in making a CAA Section 179(b) showing that it would have been in attainment, but for pollution from Mexico.)

h. **PM10 Monitoring in Nogales, Sonora**. With funding from EPA, the State of Arizona recently completed two years of $PM_{2.5}$ monitoring in Nogales, Sonora. Air quality data from these monitors will help inform both countries of the international transport of PM_{10} in the region.

i. **Bi-national Emergency Response.** The Goal 4 Task Forces regularly discuss, plan, prepare, and exercise for potential emergency responses due to the increased potential for floods, fire and severe storms as a result of climate change. EPA coordinates closely with FEMA, NOAA, the Coast Guard, other Federal agencies and State and local agencies (e.g., Proteccion Civil, County Emergency Managers, Department of Emergency Management) through both the Goal 4 task forces and the Regional Response Team.

COMMUNITY STABILITY AND HEALTH RISKS

Brief intro needed here

I. Health Risks

A. Infectious Disease)

Pertinent infectious diseases to the southwest U.S. include hantavirus, plague, dengue, and valley fever. The Sin Nombre Virus, the causative agent of hantavirus pulmonary syndrome (HPS), is transmitted to humans through airborne particles from infected rodents' feces and urine, and disease symptoms include fatigue, muscle aches, fever & dizziness eventually progressing to coughing and shortness of breath (CDC, Hantvirus, 2016). The bacterium that causes Plague, Yersinia pestis, is transmitted through fleas, rodents or through face-to-face human contact, and its symptoms include fever, fatigue and cough (CDC Plague, 2015). Both Hantavirus and Plague are more common in high elevations and outbreaks have been identified in the Four Corners region (AZ, NM, CO, UT; 1993) as well as in the western USA. Four dengue virus serotypes exist and the Aedes mosquito serves as the vector for dengue, which results in high fevers, rash, nose/gum bleeds, severe headache, and pain in the joints, muscles, and bones (CDC, Dengue, 2016). Any four of the serotypes can lead to dengue hemorrhagic fever (DHF), a potentially fatal clinical syndrome, found when more than one serotype is present. A fungus, Coccidioides immitis, found in the soil of the southwestern United States and parts of Mexico, is responsible for valley fever (Coccidioidomycosis). Individuals exposed to these fungal spores may never develop any symptoms but those that do can experience fatigue, cough, fever, muscle and join pain among other symptoms (CDC, Valley Fever, 2015). Early diagnosis is essential to preventing medical complications and death for all of these diseases.

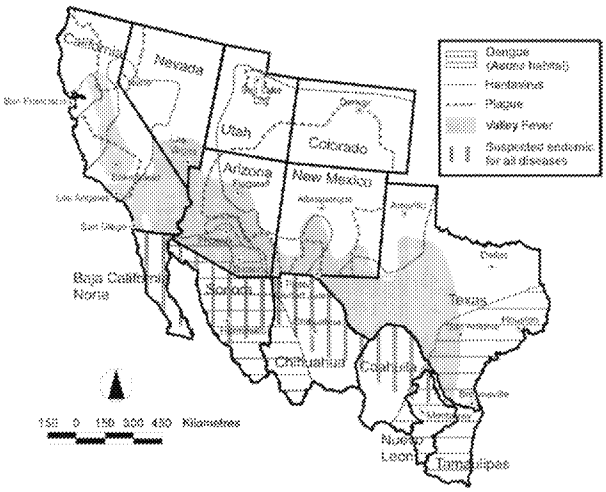


Figure 1 Generalized potential endemicity map of the Southwest for hantavirus, plague, dengue and valley fever, based on past case locations and/or animal reservoir locations

Source: Kolviras & Comrie, 2004

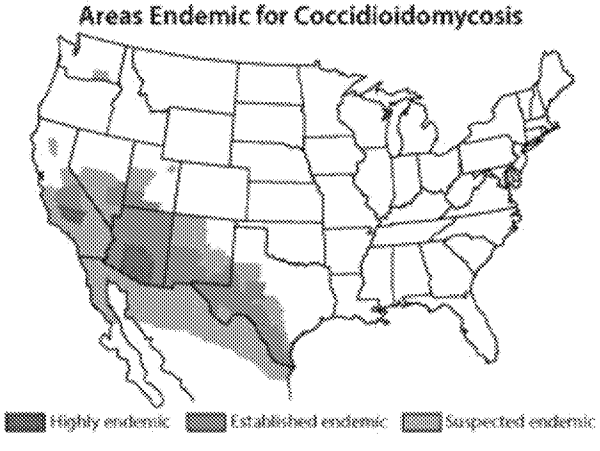
Outbreaks in the Southwest Border Region

In the U.S., (Hantavirus, CDC, 2016), four states exhibited significantly higher number of cumulative cases of Hantavirus Pulmonary Syndrome (HPS), including three of the Border States: California (62 cases), Arizona (74 cases), and New Mexico (100 cases). Colorado also demonstrated a high number of cumulative cases (94 cases). HPS demonstrates a 35% fatality rate (http://www.cdc.gov/hantavirus/surveillance/index.html). The deer mouse, found throughout North America, and common in woodlands and desert areas, is host to the Sin Nombre Virus. Male rodents are the primary sources of transmission, which occurs through increased rates of biting and scratching in infected rodents (Bagamian, et al, 2012). In 1993, a Hantavirus outbreak occurred in the four corners region, an area shared by Arizona, New Mexico, Colorado, and Utah. Unlike prior experiences identifying other Hantaviruses, which took years, the identification and isolation of the SNV occurred relatively quickly thanks to close interagency cooperation during investigation of this outbreak. Investigations revealed that the deer mouse was the main host for the previously unknown type of Hantavirus, i.e., the Sin Nombre virus (SNV). In drought for several years, the four corners region experienced heavy snows and rainfall, related to El Niño-type weather conditions, leading to larger than usual numbers of rodents thriving on revived food sources (Kolivras and Comrie, 2004). Increased contact between mice and humans lead to greater human infections. Like Hantavirus, a concentration of human plague cases have been reported in the four corners region and in the western U.S. (Kolivras and Comrie, 2004). Researchers project increases in incidence of HPS and plague across states in the western/southwestern region of the U.S. in the coming decades (Greer, Ng, and Fisman, 2008).

Dengue is typically imported to the U.S. by travelers visiting endemic countries. Dengue is currently prevalent in northern Mexico increasing potential exposure among U.S. border region residents. In 2005, the sister border cities of Brownsville, Texas and Matamoros, Tamaulipas

(Mexico) experienced a dengue-2 epidemic causing several cases of the deadly dengue hemorrhagic fever (Ramos, Mohammed, Zielinski-Gutierrez, Hayden, Robles Lopez....., 2008). Brunkard, Cifuentes, and Rothenberg (2008) assessed the roles of temperature, precipitation, and El Nino Southern Oscillation and found that for every 1 degree C increase in sea surface temperature, a 19.4% increase in dengue incidence followed. An abundant winter population of Aedes mosquitoes and mosquito infested water containers (e.g., discarded waste tires and buckets) contributed to the outbreak in both cities. Incidence was higher in Matamoros where household infrastructure that limits dengue transmission was less available (e.g., lack of air conditioners; small residential lot size). It is not clear whether the epidemic in Brownsville was largely due to cross border traffic or whether dengue is now endemic in this U.S. border city (Ramos et al., 2008). However, increased incidence and distribution of this vector-borne disease may occur along the U.S. border region due to high rates of cross border travel and low economic resources (e.g., inability to afford air conditioning or insect repellants) (Greer et al., 2008). Some researchers suggest that dengue is underreported on both sides of the border and a study by suggests that dengue fever is endemic in the Brownsville-Matamoros border region, with past infection detected in 40% of Brownsville residents and 78% of Matamoros residents (Brunkard, JM, Robles Lopez, JL, Ramirez, J, Cifuentes, E, Rothenberg, SJ, Hunsperger, EA, Moore, CG, Brussolo, RM, Villarreal, NA, and Haddad, BM, 2007).

Coccidioides, the fungus that causes Valley fever, is endemic along the U.S.-Mexico border region (CDC, 2016). The incidence of Valley fever has risen dramatically in the past two decades and infections are appearing more frequently outside of the endemic zones (Brown, Benedict, Park, and Thompson, 2013). This fungus grows best in soil following heavy rainfall and disperses in the air during hot, dry conditions. Seasonal peaks of Valley fever infections in Arizona have been associated with climatic changes, with hot, dry conditions demonstrating the strongest association with incidence (Park, Sigel, Vaz, Komatsu, McRill, Phelan, et al., 2005). A strong correlation was also identified between variations in seasonal precipitation and incidence of coccidioidomycosis reported in Arizona (Nguyen et al, 2013). A separate study found that men, persons >65 years, immunosuppressed individuals, Hispanics, Native Americans, and residents of California or Arizona were at greatest risk of coccidioidomycosis-associated deaths (Huang, Bristow, Shafir, Sorvillo, 2012).



Source: Sources of Valley Fever, CDC, http://www.cdc.gov/fungal/diseases/coccidioidomycosis/causes.html

Emerging Infectious Diseases

Emerging diseases posing a risk along the U.S.-Mexico border region include Zika virus (ZIKAV) and Chikungunya virus (CHIKV).

Zika. Expression of symptoms following initial infection varies from person to person (CDC, [HYPERLINK "http://www.cdc.gov/zika/symptoms/index.html"]). Most individuals infected with Zika will exhibit mild or no symptoms and therefore may never realize they were infected. Clinical illness occurs in approximately 20% of infected people with common symptoms including fever, rash, muscle and joint pain, conjunctivitis, and headache. The most significant risk posed by Zika is its ability to lead to microcephaly and other severe fetal brain defects, making its transmission of particular concern during pregnancy. As such, the Pan American Health Organization (PAHO) released an epidemiological alert in November 2015. ZIKAV is transmitted via mosquito bites (A. Aegypti), directly from mother to fetus during pregnancy and at birth, through blood transfusion, and through sexual contact with an infected man ([HYPERLINK "http://www.cdc.gov/zika/transmission/index.html"]). It is important to note that the virus remains present in semen longer than in blood. Men with confirmed infection or clinical illness consistent with Zika virus disease and their pregnant and non-pregnant partners should use condoms consistently and correctly during sex to reduce risk for sexual transmission ([HYPERLINK "http://www.cdc.gov/zika/transmission/index.html"]).

ZIKAV was introduced to Brazil in 2015 and is now pandemic in Latin American. To date there have been no cases of locally acquired vector-borne cases among the 472 cases reported in the U.S.; all attributed to travel or sexual transmission (Monaghan, Morin, Steinhoff, Wilhelmi, Hayden, Quattrochi, Reiskind, and Lloyd, 2016). Among the Border States, a significant number of travel-associated cases have occurred in California (40 cases) and Texas (30 cases) ([HYPERLINK "http://www.cdc.gov/zika/geo/united-states.html"]). However, Mexico is a designated country with active Zika virus transmission reported (http://www.cdc.gov/zika/geo/active-countries.html). Bi-directional cross border traffic makes the U.S.-Mexico border region a high-risk region for travel-associated infections, particularly if increased cases of Zika infections is identified in northern Mexico. Furthermore, the Aedes Aegypti mosquito does not recognize political borders and as such, the risk for locally acquired vector-borne cases (i.e., autochthonous transmission) should be carefully monitored. The climate of south Texas region, in particular, has been identified as highly suitable year round for this mosquito and the region lends itself to introduction of the ZIKAV via high-frequency cross border travel with Mexico (Monaghan, et al., 2016). Several other cities in the Border States demonstrate suitable climates for this mosquito May through November, with the summer months demonstrating peak suitability (Monaghan, et al, 2016). High poverty rates in the border region also increase susceptibility of human exposure to Aedes aegypti and its viral transmission. This is because poverty is associated with lack of air conditioners, open windows and doors lacking screens, water storage units in communities lacking access to piped water (e.g., colonias along the U.S. Mexico border), and other living conditions increasing human

exposure to vectors (Monaghan, et al., 2016).

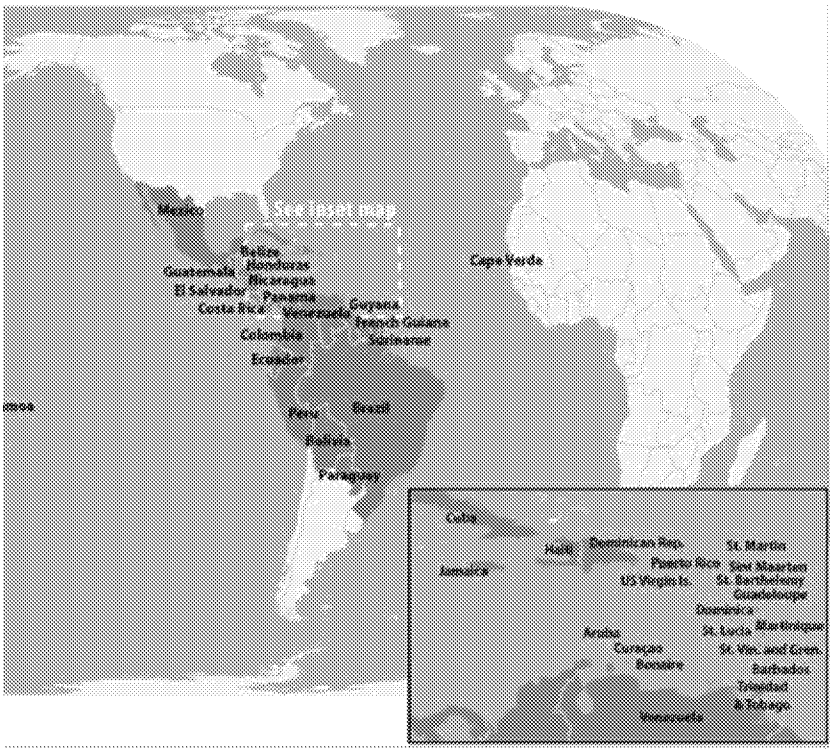


Figure #: Latin American Countries and Territories with Active Zika Virus Transmission
Source: CDC, [HYPERLINK "http://www.cdc.gov/zika/geo/active-countries.html"]

Chikungunya. The Chikungunya virus (CHIKV) was discovered in the Americas in 2013. As with Zika virus and Dengue virus, the Aedes Aegypti mosquito is the primary vector in the transmission of the Chikungunya virus (CHIKV). However, unlike Zika, chikungunya is rarely transmitted from mother to a newborn. Although infection with chikungunya rarely results in death, it can lead to severe and disabling symptoms (http://www.cdc.gov/chikungunya/symptoms/index.html). For example one of its most common symptoms, joint swelling and pain, may persist for months following infection. It is also important to note that, unlike with Zika, most people infected with chikungunya do develop symptoms, these occurring within 3-7 days of initial infection.

In 2015, 679 cases of new chikungunya-related illness onset were reported in the U.S.; all attributed to travelers returning from affected areas (http://www.cdc.gov/chikungunya/geo/united-states-2015.html). Among the Border States, a significant number of travel-associated cases have occurred in California (176 cases), Texas (43 cases), and Arizona (19) accounting for 35% of all laboratory-confirmed cases chikungunya in 2015 (http://www.cdc.gov/chikungunya/geo/united-states-2015.html).

Climate Change Impact on Infectious Diseases

Scientists have recognized the strong impact of climate variability on these infectious diseases along the southwestern USA (Kolivras and Comrie, 2004). Increased patterns of precipitation in the southwest region have been linked to higher incidence and wider dispersal of such infectious diseases for up to two years following such climate changes (Kolivras and Comrie, 2004). Increased moisture in this typically hot and arid region promotes infectious diseases directly by promoting the survival and dispersal of infectious agents and indirectly by promoting survival and growth of animal hosts. The reduction in rodent biodiversity in this southwest region has also been associated with more efficient transmission of a virus within the host population and higher prevalence of infection in the host, ultimately leading to greater risk to humans (Mills 2006).

Future Research Needs

Greater surveillance of vectors and analysis of the mediating mechanisms/processes between climate change (e.g., increases in precipitation) and disease outbreak is needed. Surveillance of disease vectors should be systematic and well-distributed along the U.S. Mexico border, particularly cities with high cross border traffic, in order to (1) accurately determine prevalence of infected vectors/hosts, (2) prevent and manage outbreaks and (3) tailor warning messages to border communities at risk for infection (Monaghan, et al. 2016). Understanding how climate-related variations in vector habitats and human behavior (e.g., water storage and irrigation, pollution, migration, travel) contribute to disease outbreaks in the border region is also important (Esteve-Gassent et al., 2014). Improved diagnostic/detection techniques (e.g., urine versus blood tests) and training of medical personnel (especially those serving low SES communities) can facilitate early and effective treatment and a reduction in morbidity/mortality rates along the border. There is also a need to improve mechanisms for reporting cases in order to identify endemic regions more effectively. Finally, public health campaigns to increase awareness and education of infectious diseases pertinent to the U.S.-Mexico border region are essential to prevention, especially concerning vulnerable populations at increased risk for development of these diseases. As Greer et al. (2008, pg 716) conclude, "The best defense against increases in infectious disease burden related to climate change lies in strengthening existing public health infrastructure." Finally, it is important to highlight the need to consider the U.S.-Mexico border region as a contiguous landscape where vector and zoonotic pathogens thrive and circulate across political borders. To mitigate the health burden of these infectious diseases effectively, surveillance systems must follow a shared border region perspective and a One Health approach (Esteve-Gassent, et al, 2014).

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Ramos, M.M., Mohammed, H. Zielinski-Gutierrez, E., Hayden, M.H., Robles Lopez, J.L., et al., (2008). Epidemic Dengue and Dengue Hemorrhagic Fever at the Texas–Mexico Border: Results of a Household-based Seroepidemiologic Survey, December 2005. Am. J. Trop. Med. Hyg., 78(3), 364–369

B. The Impact of Heat Waves on Public Health along the US/Mexico Border (Draft by Rebecca Palacios, Jenna Kendal, Lauren Baldwin)

There is a relationship between climate change and the frequency, intensity, and duration of extreme heat events [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"20g5jd6hdd","properties":{"formattedCitation":"(Luber & McGeehin, 2008)","plainCitation":"(Luber & McGeehin, 2008)"},"citationItems":[{"id":140,"uris":["http://zotero.org/users/2904799/items/TI8SNW4B"],"uri":["http://zotero.org/users/2904799/items/TI8SNW4B"],"itemData":{"id":140,"type":"article-journal","title":"Climate change and extreme heat events","container-title":"American Journal of Preventive Medicine","page":"429-435","volume":"35","issue":"5","source":"PubMed","abstract":"The association between climate change and the frequency and intensity of extreme heat events is now well established. General circulation models of climate change predict that heatwaves will become more frequent and intense, especially in the higher latitudes, affecting large metropolitan areas that are not well adapted to them. Exposure to extreme heat is already a significant public health problem and the primary cause of weather-related mortality in the U.S. This article reviews major epidemiologic risk factors associated with mortality from extreme heat exposure and discusses future drivers of heat-related mortality, including a warming climate, the urban heat island effect, and an aging population. In addition, it considers critical areas of an effective public health response including heat response plans, the use of remote sensing and GIS methodologies, and the importance of effective communications strategies.","DOI":"10.1016/j.amepre.2008.08.021","ISSN":"1873-2607","note":"PMID: 18929969","journalAbbreviation":"Am J Prev Med","language":"eng","author":[{"family":"Luber","given":"George"},{"family":"McGeehin","given":"Michael"}],"issued":{"date-parts":[["2008",11]]},"PMID":"18929969"}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Extreme heat is defined as temperatures that are significantly higher than the average temperature in a specific place during a specific period of time (Centers for Disease Control and Prevention, 2015). An extreme heat event is described as having stationary masses of warm air with successive nights of high minimum temperatures [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"2o6apjnof3","properties":{"formattedCitation":"(Luber & McGeehin, 2008)","plainCitation":"(Luber & McGeehin, 2008)"},"citationItems":[{"id":140,"uris":["http://zotero.org/users/2904799/items/TI8SNW4B"],"uri":["http://zotero.org/users/2904799/items/TI8SNW4B"],"itemData":{"id":140,"type":"article-journal","title":"Climate change and extreme heat events","container-title":"American Journal of Preventive Medicine","page":"429-435","volume":"35","issue":"5","source":"PubMed","abstract":"The association between climate change and the frequency and intensity of extreme heat events is now well established. General circulation models of climate change predict that heatwaves will become more frequent and intense, especially in the higher latitudes, affecting large metropolitan areas that are not well adapted to them. Exposure to extreme heat is already a significant public health problem and the primary cause of weather-related mortality in the U.S. This article reviews major epidemiologic risk factors associated with mortality from extreme heat exposure and discusses future drivers of heat-related mortality, including a warming climate, the urban heat island effect, and an aging population. In addition, it considers critical areas of an effective public health response including

heat response plans, the use of remote sensing and GIS methodologies, and the importance of effective communications strategies.","DOI":"10.1016/j.amepre.2008.08.021","ISSN":"1873-2607","note":"PMID: 18929969","journalAbbreviation":"Am J Prev Med","language":"eng","author":[{"family":"Luber","given":"George"},{"family":"McGeehin","given":"Michael"}],"issued":{"date-parts":[["2008",11]]},"PMID":"18929969"}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Changes in stratospheric ozone will affect levels of ambient ultraviolet radiation (UVR) and this in combination with higher temperatures will have an impact on sun exposure behavior [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"1nnlj02hir","properties":{"formattedCitation":"(Thomas, Swaminathan, & Lucas, 2012)","plainCitation":"(Thomas, Swaminathan, & Lucas, 2012)"},"citationItems":[{"id":20,"uris":["http://zotero.org/users/2904799/items/GRFAH944"],"uri":["http://zotero.org/users/2904799/items/GRFAH944"],"itemData":{"id":20,"type":"article-journal","title":"Climate change and health with an emphasis on interactions with ultraviolet radiation: a review","container-title":"Global Change Biology","page":"2392-2405","volume":"18","issue":"8","source":"EBSCOhost","abstract":"Climate change is increasingly recognized as a major risk to human health, and health concerns are assuming more importance in international debates on mitigation and adaptation strategies. Health consequences of climate change will occur through direct and indirect routes, and as a result of interactions with other environmental exposures. Heatwaves will become more common and are associated with higher mortality particularly in the elderly and those with pre-existing cardiovascular and respiratory illnesses. Warmer ambient temperatures will result in more dehydration episodes and increased risks of renal disease and, through effects on pollen seasons, there may be an increase in allergic disease such as asthma and hayfever. Other adverse effects including on air quality, food safety and security and an expanding distribution of some infectious diseases, including vector-borne diseases, are postulated. A related but separate environmental exposure is that of ultraviolet radiation (UVR). Interactions between climate change and stratospheric ozone (and the causes of ozone depletion) will cause changes to levels of ambient UVR in the future and warmer temperatures are likely to change sun exposure behaviour. Co-occurring effects on aquatic and terrestrial ecosystems have potential consequences for food safety, quality and supply. Climate change-related exposures are likely to affect the incidence and distribution of diseases usually considered as caused by UVR exposure; and changes in UVR exposure will modulate the climate change effects on human health. For example, in some regions warmer temperatures due to climate change will encourage more outdoor behaviour, with likely consequences for increasing skin cancer incidence. Although many of the health outcomes of both climate change and the interaction of climate change and UVR exposure are somewhat speculative, there are risks to over- or under-estimations of health risks if synergistic and antagonistic effects of co-occurring environmental changes are not considered.","ISSN":"1354-1013","shortTitle":"Climate change and health with an emphasis on interactions with ultraviolet radiation","journalAbbreviation":"Global Change Biology","author":[{"family":"Thomas","given":"P."},{"family":"Swaminathan","given":"A."},{"family":"Lucas","given":"R. M."}],"issued":{"date-parts":[["2012"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}].

As mentioned previously, global temperatures are rising and it is understood that an

increase in average temperatures will intensify evaporation: "the physical principles of the hydrologic cycle show that increasing average temperatures will intensify evaporation, which will subsequently increase precipitation" (Mills). Luber adds that urbanization and an aging population, in addition to a warming climate, will lead to a "significant public health problem" (Luber). In fact, "over a 5-year period, from 1999 to 2003, a total of 3442 heat-related deaths were reported in the U.S. (an annual average of 688)" (Luber).

The Southwest is recognized as the hottest and driest region in the U.S. with climate change contributing to increased temperatures throughout the 20th century. In addition, the most recent decade (2001-2010) has been the warmest on record (Garfin et al., 2014). In 2013, 46 record high temperatures were matched or exceeded in the southwest region. If global emissions continue to grow, projections suggest that the Southwest regional average annual temperature will increase by 2.5 to 5.5 degrees Fahrenheit between 2041-2070 and by 5.5°F to 9.5°F between 2070-2099. Reducing emissions dramatically would reduce these projected increases to only 2.5°F to 4.5°F (2041-2070), and 3.5°F to 5.5°F (2070-2099) [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"1ifu45ct8c","properties":{"formattedCitation":"(National Climate Change Assessment, 2014)","plainCitation":"(National Climate Change Assessment, 2014)"},"citationItems":[{"id":510,"uris":["http://zotero.org/users/2904799/items/NX7TQ8PK"],"uri":["http://zotero.org/users/2904799/items/NX7TQ8PK"],"itemData":{"id":510,"type":"webpage","title":"Southwest","URL":"http://nca2014.globalchange.gov/report/regions/southwest","author":[{"literal":"National Climate Change Assessment"}],"issued":{"date-parts":[["2014"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Figure 1 below depicts the projected temperature increases in the Southwest region.

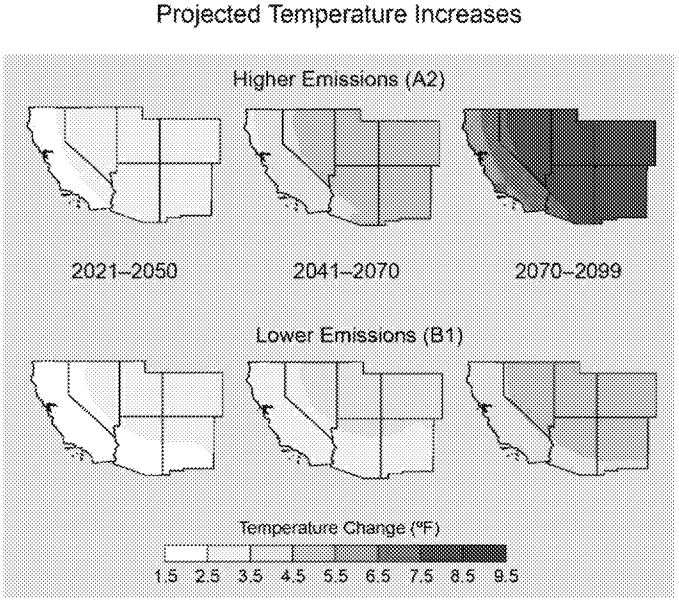
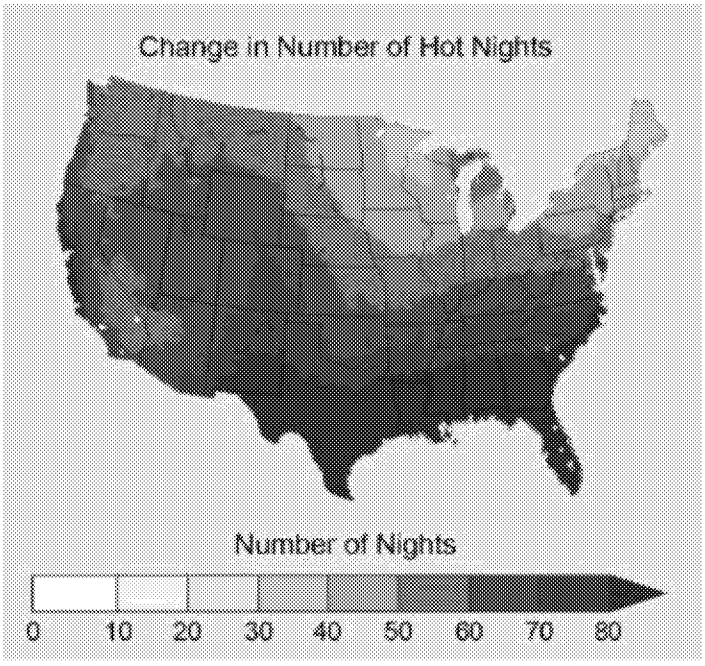


Figure #: Projected temperature increases. (Figure source: National Climate Assessment, 2014; original source adapted from Kunkel et al. 2013).

Toward end of the century (2077-2099) the number of hot nights will also increase significantly compared to the timeframe between 1971-2000 (see Figure #). Such changes will affect the Texas and New Mexico border regions most intensely.



Source: CICS-NC RISA, prepared for NCA3 [HYPERLINK "https://www.cicsnc.org/about/tsu/nca3-data"]

Increasing temperature in this region will exacerbate existing drought conditions and affect important water sources, such as the Colorado River Basin (Garfin et al., 2014). Increased evaporation resulting from warming temperatures will cause river-flow reductions and dwindling water reservoirs. Furthermore, climate change is contributing to declines in snowpack, runoff, and soil moisture (https://www3.epa.gov/climatechange/impacts/southwest.html). Finally, rapid population growth in this region will further strain limited water resources needed for cities, agriculture, and energy production. Approximately 13 million people live in the border region and the population is projected to double by the year 2025 [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"3ugeq2v4d","properties":{"formattedCitation":"(National Rural Health Association, 2010)","plainCitation":"(National Rural Health Association, 2010)"},"citationItems":[{"id":511,"uris":["http://zotero.org/users/2904799/items/RKXKDQX4"],"uri":["http://zotero.org/users/2904799/items/RKXKDQX4"],"itemData":{"id":511,"type":"webpage","title":"Addressing the Health Care Needs in the U.S.-Mexico Border Region.","container-title":"National Rural Health Association Policy Brief","URL":"http://www.nrharural.org","author":[{"literal":"National Rural Health Association"}],"issued":{"date-parts":[["2010"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. It is likely that climate change will unevenly impact health in the border region with a population that is culturally and institutionally diverse and economic development distributed disparately [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"2qamrg2nnb","properties":{"formattedCitation":"(Wilder et al., 2013)","plainCitation":"(Wilder et al., 2013)"},"citationItems":[{"id":509,"uris":["http://zotero.org/users/2904799/items/SGCCKTDQ"],"uri":["http://zotero.org/users/2904799/items/SGCCKTDQ"],"itemData":{"id":509,"type":"repo

rt","title":"Climate Change and U.S.- Mexico Border Communities." In Assessment of Climate Change in the Southwest United States: A Report Prepared for \tthe National Climate Assessment","publisher":"Southwest Climate Change Alliance","publisher-place":"Washington, DC","page":"340-384","event-place":"Washington, DC","author":[{"family":"Wilder","given":"M."},{"family":"Garfin","given":"G."},{"family":"Ganster","given":"P."},{"family":"Eaken","given":"H."},{"family":"Romero-Lankao","given":"P."},{"family":"Lara-Valencia","given":"F."},{"family":"Muñoz-Arrioloa","given":"F."}],"issued":{"date-parts":[["2013"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}].

Impact on Human Health along the U.S.-Mexico border region

Exposure to high heat can affect the body's ability to regulate temperature and this results in physiologic strain, which can lead to death [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"2d2n2npre1","properties":{"formattedCitation":"(Reid et al., 2009)","plainCitation":"(Reid et al., 2009)"},"citationItems":[{"id":354,"uris":["http://zotero.org/users/2904799/items/GDVRJRF5"],"uri":["http://zotero.org/users/2904799/items/GDVRJRF5"],"itemData":{"id":354,"type":"article-journal","title":"Mapping Community Determinants of Heat Vulnerability","container-title":"Environmental Health Perspectives","page":"1730-6","volume":"117","issue":"11","source":"ProQuest","abstract":"The evidence that heat waves can result in both increased deaths and illness is substantial, and concern over this issue is rising because of climate change. Adverse health impacts from heat waves can be avoided, and epidemiologic studies have identified specific population and community characteristics that mark vulnerability to heat waves.\nWe situated vulnerability to heat in geographic space and identified potential areas for intervention and further research.\nWe mapped and analyzed 10 vulnerability factors for heat-related morbidity/mortality in the United States: six demographic characteristics and two household air conditioning variables from the U.S. Census Bureau, vegetation cover from satellite images, and diabetes prevalence from a national survey. We performed a factor analysis of these 10 variables and assigned values of increasing vulnerability for the four resulting factors to each of 39,794 census tracts. We added the four factor scores to obtain a cumulative heat vulnerability index value.\nFour factors explained > 75% of the total variance in the original 10 vulnerability variables: a) social/environmental vulnerability (combined education/poverty/race/green space), b) social isolation, c) air conditioning prevalence, and d) proportion elderly/diabetes. We found substantial spatial variability of heat vulnerability nationally, with generally higher vulnerability in the Northeast and Pacific Coast and the lowest in the Southeast. In urban areas, inner cities showed the highest vulnerability to heat.\nThese methods provide a template for making local and regional heat vulnerability maps. After validation using health outcome data, interventions can be targeted at the most vulnerable populations.","ISSN":"00916765","language":"English","author":[{"family":"Reid","given":"Colleen E."},{"family":"O'Neill","given":"Marie S."},{"family":"Gronlund","given":"Carina J."},{"family":"Brines","given":"Shannon J."},{"family":"Brown","given":"Daniel G."},{"family":"Diez-Roux","given":"Ana V."},{"family":"Schwartz","given":"Joel"}],"issued":{"date-parts":[["2009",11]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Extended exposure to high heat can lead to

multiple health issues, including heat exhaustion, heat stroke, heat syncope, and death [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"q7l1npqkc","properties":{"formattedCitation":"(Luber & McGeehin, 2008)","plainCitation":"(Luber & McGeehin, 2008)"},"citationItems":[{"id":140,"uris":["http://zotero.org/users/2904799/items/TI8SNW4B"],"uri":["http://zotero.org/users/2904799/items/TI8SNW4B"],"itemData":{"id":140,"type":"article-journal","title":"Climate change and extreme heat events","container-title":"American Journal of Preventive Medicine","page":"429-435","volume":"35","issue":"5","source":"PubMed","abstract":"The association between climate change and the frequency and intensity of extreme heat events is now well established. General circulation models of climate change predict that heatwaves will become more frequent and intense, especially in the higher latitudes, affecting large metropolitan areas that are not well adapted to them. Exposure to extreme heat is already a significant public health problem and the primary cause of weather-related mortality in the U.S. This article reviews major epidemiologic risk factors associated with mortality from extreme heat exposure and discusses future drivers of heat-related mortality, including a warming climate, the urban heat island effect, and an aging population. In addition, it considers critical areas of an effective public health response including heat response plans, the use of remote sensing and GIS methodologies, and the importance of effective communications strategies.","DOI":"10.1016/j.amepre.2008.08.021","ISSN":"1873-2607","note":"PMID: 18929969","journalAbbreviation":"Am J Prev Med","language":"eng","author":[{"family":"Luber","given":"George"},{"family":"McGeehin","given":"Michael"}],"issued":{"date-parts":[["2008",11]]},"PMID":"18929969"}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Warmer temperatures will result in higher incidences of dehydration and renal diseases, as well as asthma, hay fever, and other allergy-related diseases brought on by climate change impacts on pollen seasons [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"aik7419tg","properties":{"formattedCitation":"(Thomas et al., 2012)","plainCitation":"(Thomas et al., 2012)"},"citationItems":[{"id":20,"uris":["http://zotero.org/users/2904799/items/GRFAH944"],"uri":["http://zotero.org/users/2904799/items/GRFAH944"],"itemData":{"id":20,"type":"article-journal","title":"Climate change and health with an emphasis on interactions with ultraviolet radiation: a review","container-title":"Global Change Biology","page":"2392-2405","volume":"18","issue":"8","source":"EBSCOhost","abstract":"Climate change is increasingly recognized as a major risk to human health, and health concerns are assuming more importance in international debates on mitigation and adaptation strategies. Health consequences of climate change will occur through direct and indirect routes, and as a result of interactions with other environmental exposures. Heatwaves will become more common and are associated with higher mortality particularly in the elderly and those with pre-existing cardiovascular and respiratory illnesses. Warmer ambient temperatures will result in more dehydration episodes and increased risks of renal disease and, through effects on pollen seasons, there may be an increase in allergic disease such as asthma and hayfever. Other adverse effects including on air quality, food safety and security and an expanding distribution of some infectious diseases, including vector-borne diseases, are postulated. A related but separate environmental exposure is that of ultraviolet radiation (UVR). Interactions between climate change and stratospheric ozone (and the causes of ozone depletion) will cause changes to levels of ambient UVR in the future and

warmer temperatures are likely to change sun exposure behaviour. Co-occurring effects on aquatic and terrestrial ecosystems have potential consequences for food safety, quality and supply. Climate change-related exposures are likely to affect the incidence and distribution of diseases usually considered as caused by UVR exposure; and changes in UVR exposure will modulate the climate change effects on human health. For example, in some regions warmer temperatures due to climate change will encourage more outdoor behaviour, with likely consequences for increasing skin cancer incidence. Although many of the health outcomes of both climate change and the interaction of climate change and UVR exposure are somewhat speculative, there are risks to over- or under-estimations of health risks if synergistic and antagonistic effects of co-occurring environmental changes are not considered.","ISSN":"1354-1013","shortTitle":"Climate change and health with an emphasis on interactions with ultraviolet radiation","journalAbbreviation":"Global Change Biology","author":[{"family":"Thomas","given":"P."},{"family":"Swaminathan","given":"A."},{"family":"Lucas","given":"R. M."}],"issued":{"date-parts":[["2012"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}].

Heat-stress is a leading cause of death in the southwest and as heat waves continue increasing in number, length and intensity, so will heat-related death rates ([HYPERLINK "https://www3.epa.gov/climatechange/impacts/southwest.html"]). Those at highest risk for heat stress include elderly populations and low income households who may not have access to air conditioning [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"kpsb2pmgq","properties":{"formattedCitation":"(Reid et al., 2009)","plainCitation":"(Reid et al., 2009)"},"citationItems":[{"id":354,"uris":["http://zotero.org/users/2904799/items/GDVRJRF5"],"uri":["http://zotero.org/users/2904799/items/GDVRJRF5"],"itemData":{"id":354,"type":"article-journal","title":"Mapping Community Determinants of Heat Vulnerability","container-title":"Environmental Health Perspectives","page":"1730-6","volume":"117","issue":"11","source":"ProQuest","abstract":"The evidence that heat waves can result in both increased deaths and illness is substantial, and concern over this issue is rising because of climate change. Adverse health impacts from heat waves can be avoided, and epidemiologic studies have identified specific population and community characteristics that mark vulnerability to heat waves.\nWe situated vulnerability to heat in geographic space and identified potential areas for intervention and further research.\nWe mapped and analyzed 10 vulnerability factors for heat-related morbidity/mortality in the United States: six demographic characteristics and two household air conditioning variables from the U.S. Census Bureau, vegetation cover from satellite images, and diabetes prevalence from a national survey. We performed a factor analysis of these 10 variables and assigned values of increasing vulnerability for the four resulting factors to each of 39,794 census tracts. We added the four factor scores to obtain a cumulative heat vulnerability index value.\nFour factors explained > 75% of the total variance in the original 10 vulnerability variables: a) social/environmental vulnerability (combined education/poverty/race/green space), b) social isolation, c) air conditioning prevalence, and d) proportion elderly/diabetes. We found substantial spatial variability of heat vulnerability nationally, with generally higher vulnerability in the Northeast and Pacific Coast and the lowest in the Southeast. In urban areas, inner cities showed the highest vulnerability to heat.\nThese methods provide a template for making local and regional heat vulnerability maps.

After validation using health outcome data, interventions can be targeted at the most vulnerable populations.","ISSN":"00916765","language":"English","author":[{"family":"Reid","given":"Colleen E."},{"family":"O'Neill","given":"Marie S."},{"family":"Gronlund","given":"Carina J."},{"family":"Brines","given":"Shannon J."},{"family":"Brown","given":"Daniel G."},{"family":"Diez-Roux","given":"Ana V."},{"family":"Schwartz","given":"Joel"}],"issued":{"date-parts":[["2009",11]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Approximately 25% of residents living on the U.S. side of the border are living at or below the poverty level whereas 28% of residents in the Mexican Border States are living in poverty [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"9rehjjeu3","properties":{"formattedCitation":"(Migration Policy Institute, n.d.)","plainCitation":"(Migration Policy Institute, n.d.)","dontUpdate":true},"citationItems":[{"id":360,"uris":["http://zotero.org/users/2904799/items/HXWDPA3S"],"uri":["http://zotero.org/users/2904799/items/HXWDPA3S"],"itemData":{"id":360,"type":"webpage","title":"The U.S.-Mexico Border","URL":"http://www.migrationpolicy.org/article/us-mexico-border","author":[{"literal":"Migration Policy Institute"}],"issued":{"date-parts":[["2006"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}] [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"vilg91lrs","properties":{"formattedCitation":"(Migration Policy Institute, 2006)","plainCitation":"(Migration Policy Institute, 2006)"},"citationItems":[{"id":360,"uris":["http://zotero.org/users/2904799/items/HXWDPA3S"],"uri":["http://zotero.org/users/2904799/items/HXWDPA3S"],"itemData":{"id":360,"type":"webpage","title":"The U.S.-Mexico Border","URL":"http://www.migrationpolicy.org/article/us-mexico-border","author":[{"literal":"Migration Policy Institute"}],"issued":{"date-parts":[["2006"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Other populations particularly vulnerable to heat stress are children, and people with pre-existing health conditions, such as cardiovascular disease, diabetes, hypertension, and obesity [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"188v1is9nl","properties":{"formattedCitation":"(Luber & McGeehin, 2008)","plainCitation":"(Luber & McGeehin, 2008)"},"citationItems":[{"id":140,"uris":["http://zotero.org/users/2904799/items/TI8SNW4B"],"uri":["http://zotero.org/users/2904799/items/TI8SNW4B"],"itemData":{"id":140,"type":"article-journal","title":"Climate change and extreme heat events","container-title":"American Journal of Preventive Medicine","page":"429-435","volume":"35","issue":"5","source":"PubMed","abstract":"The association between climate change and the frequency and intensity of extreme heat events is now well established. General circulation models of climate change predict that heatwaves will become more frequent and intense, especially in the higher latitudes, affecting large metropolitan areas that are not well adapted to them. Exposure to extreme heat is already a significant public health problem and the primary cause of weather-related mortality in the U.S. This article reviews major epidemiologic risk factors associated with mortality from extreme heat exposure and discusses future drivers of heat-related mortality, including a warming climate, the urban heat island effect, and an aging population. In addition, it considers critical areas of an effective public health response including heat response plans, the use of remote sensing and GIS methodologies, and the importance of effective communications strategies.","DOI":"10.1016/j.amepre.2008.08.021","ISSN":"1873-

2607","note":"PMID: 18929969","journalAbbreviation":"Am J Prev Med","language":"eng","author":[{"family":"Luber","given":"George"},{"family":"McGeehin","given":"Michael"}],"issued":{"date-parts":[["2008",11]]},"PMID":"18929969"}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. People with asthma and other respiratory illnesses are also vulnerable since high temperatures contribute to poor air quality, including the formation of ground-level ozone ([HYPERLINK "https://www3.epa.gov/climatechange/impacts/southwest.html"]). Finally, people suffering from mental illness exhibit triple the risk of death during heat waves (USGCRP, 2016).

Disruptions to urban electricity and water supplies may further aggravate health problems in the southwest region. For example, increased energy use for cooling during heatwaves may place additional strain on the electric grid ultimately resulting in brownouts or power outages (Garfin et al, 2014). Greater water demand in growing cities along the border and reduced water availability could also affect access to drinking water. Shallow wells in rural border regions are drying up and reducing drinking water supplies available to Native American and Hispanics.

Vulnerability and Resiliency

Vulnerability is the point to which a system is unable to handle and cope with the negative impacts of unpredictable and global climate change [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"29uk1v0oio","properties":{"formattedCitation":"(Vasquez-De Leon, West, & Finan, 2003)","plainCitation":"(Vasquez-De Leon, West, & Finan, 2003)"},"citationItems":[{"id":508,"uris":["http://zotero.org/users/2904799/items/S2AD6R85"],"uri":["http://zotero.org/users/2904799/items/S2AD6R85"],"itemData":{"id":508,"type":"article-journal","title":"A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US–Mexico border","container-title":"Global Environmental Change","page":"159-173","volume":"13","author":[{"family":"Vasquez-De Leon","given":"Marcela"},{"family":"West","given":"C. T."},{"family":"Finan","given":"T. J."}],"issued":{"date-parts":[["2003"]]}}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Resiliency only goes so far in reducing the health impact burden on the population. The border region has a higher than average yearly temperature relative to other areas of the country and the temperature is continuing to rise. This will disproportionately impact vulnerable residents, including Hispanics and Native Americans, children, people living in rural areas, low-income residents, older adults, people without air conditioning in their homes, and people with pre-existing health conditions.

Recommendations

Proactive public health strategies will be necessary for reducing the impact and burden of extreme heat [ADDIN ZOTERO_ITEM CSL_CITATION {"citationID":"2pk8cd4258","properties":{"formattedCitation":"(Krueger, Biedrzycki, & Hoverter, 2015)","plainCitation":"(Krueger, Biedrzycki, & Hoverter, 2015)"},"citationItems":[{"id":6,"uris":["http://zotero.org/users/2904799/items/R2X3QA2F"],"uri":["http://zotero.org/users/2904799/items/R2X3QA2F"],"itemData":{"id":6,"type":"article-journal","title":"Human Health Impacts of Climate Change: Implications for the Practice and Law of Public Health","container-title":"Journal of Law, Medicine & Ethics","page":"79-82 4p","volume":"43","source":"EBSCOhost","abstract":"This article describes the health impacts

of climate change, especially upon vulnerable populations. The bulk of the article sets forth legal and public health strategies to lessen the health impacts of climate change through adaptation and mitigation at the local, state, and national levels. It will demonstrate that action to address this emerging threat to public health is both achievable and necessary and will provide examples of current successes and challenges.","DOI":"10.1111/jlme.12223","ISSN":"1073-1105","shortTitle":"Human Health Impacts of Climate Change","journalAbbreviation":"Journal of Law, Medicine & Ethics","author":[{"family":"Krueger","given":"Jill"},{"family":"Biedrzycki","given":"Paul"},{"family":"Hoverter","given":"Sara Pollock"}],"issued":{"date-parts":[["2015",3,2]]}}],"schema":"https://github.com/citation-style-language/schema/raw/master/csl-citation.json"}]. Models predicting extreme heat waves are needed to (1) warn border populations in the southwest, (2) plan and execute appropriate interventions/assistance for vulnerable populations, (3) secure access to support services and resources (e.g., electricity, water). Land use policy and building codes aimed at reducing urban heat islands will be critical during future development.

In April 2016, the National Oceanic and Atmospheric Administration (NOAA) started discussions with El Paso leadership to discuss the feasibility of an early heat health warning system in the Paso del Norte Region with the hopes of providing emergency responders the time they need to connect with and support residents before an extreme heat event. El Paso experiences an average of 15 hundred-degree days a year, so an early heat health warning system could potentially benefit thousands of vulnerable residents in this region.

Adaptation to these events is required. This would be related to better prediction of these extreme weather events, subsidizing air-conditioning for vulnerable populations, providing cold and warm emergency shelters for extended periods in geographically vulnerable areas and communities. The focus is on events with above average nighttime heat. Educate vulnerable populations about the risks and prevention from heat waves.

We recommend direct funding be provided in the form of grants to any community organization that is willing to support vulnerable populations during times of temperature extremes. Many vulnerable communities are located along the U.S.-Mexican border and would benefit greatly from support during temperature extremes. The direct funding would be given to eligible community groups, to include senior centers, churches, community centers, social justice groups, and recreation centers, to purchase fans, potentially A/C units, blankets, and proper clothing, and provide them to community members. This would reach community members that are normally difficult to reach because outreach would be done through their social networks, with which they are comfortable. Funding for fans, blankets, clothing, and other commodities would reduce vulnerability to heat and cold: “There is a high level of certainty that an increase in the frequency and intensity of heatwaves would increase the numbers of additional deaths due to hot weather” (Hales).

In addition, many communities along the U.S.-Mexico border are desert communities and have a sparse shade canopy—for example, in El Paso, Texas, there is only a 5.1% shade canopy across the city and this provides little relief for community members searching for shade during times

of extreme heat (Davey Resource Group). We recommend providing direct funding to local governments to identify tree planting areas, install irrigation, purchase and plant native shade-providing trees, install three-tier water fountains, benches and other shade structures. This will help lower temperatures in border communities as we experience increased temperature extremes: "Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmosphere environment. Four main ways that urban trees affect air quality are temperature reduction and other microclimate effects, removal of air pollutants, emission of volatile organic compounds (VOC) and tree maintenance emissions, and energy effects on buildings" (Nowak). In addition to direct funding for materials, we recommend direct funding for volunteers to organize tree plantings and coordinate installation of irrigation, trees, water fountains, and other shade structures.

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Centers for Disease Control and Prevention. (2015). *Extreme heat prevention guide.* Retrieved from [HYPERLINK "http://emergency.cdc.gov/disasters/extremeheat/heat_guide.asp"]

Environmental Protection Agency, Climate Impacts in the Southwest. Retrieved from [HYPERLINK "https://www3.epa.gov/climatechange/impacts/southwest.html"]

Garfin, G., G. Franco, H. Blanco, A. Comrie, P. Gonzalez, T. Piechota, R. Smyth, and R. Waskom, 2014: Ch. 20: Southwest. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 462-486. doi:10.7930/J08G8HMN.

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C. Respiratory Problems (Wael, Evaristo, Baldwin)

In many cities along the U.S.-Mexico border, air pollution is an increasing concern. A critical challenge to air quality along the border includes International ports of entry and associated traffic emissions from idling vehicles. Along the US Mexico border there are 43 points of entry and in 2011, 4.8 million commercial trucks and 61.2 million personal vehicles crossed the border northbound (Quintana, et, al., 2012). In addition to motor vehicle traffic 40.2 million pedestrians also crossed northbound (Quintana, et, al., 2012). With recent transportation and air quality impact studies it was been determined that future utilization of these ports of entry will continue to rise. Reports from the El Paso Metropolitan Planning organization indicate that in El Paso County through its five international ports of entry there are an estimated 1,336,716 total passenger vehicles crossing per month (Sosa et. al., 2012). Future Growth projections indicate that with increases in traffic there are needs continual improvement of vehicle emission standards.

A positive association has been found between temperatures 32°C (90°F) and ground-level ozone production, and increasing evidence suggests that ozone and high temperature affect mortality synergistically. Similarly, heatwave mortality is greatest on days with high PM10 (particulate matter with diameter under 10m)" (Luber). Since ozone formation is temperature dependent, surface ozone concentration are projected to increase with a warmer climate. Ozone damages lung tissue, causing particular problems for people with asthma and other lung diseases. Even modest exposure to ozone may encourage the development of asthma in children. Ozone and non-volatile secondary particulate matter generally increase at higher temperatures, due to increased gas-phase reaction rates. Many species of trees emit volatile organic compounds (VOCs) such as isoprene, which is a precursor of ozone formation, at rates that increase rapidly with temperature. The projected number of heat wave days in Los Angeles increases from 12 to 44-95 days.

Combustion of fossil fuel and biomass fuel for energy, transportation, trash burning or other reasons also affects the health of individuals. Household burning of solid fuel expose 2.8 billion people, increasing their mortality (estimated 4.3 million deaths annually) and morbidity from respiratory and cardiovascular diseases. In addition to C02, black carbon, methane, ozone and sulphate are other sources of global warming and also impact health. Dust is also a consequence of climate change and drought leading to inhalation of pollutants attached to dust.

Climate change may have very serious health impacts in the border region given its hot and dry climate, existing environmental hazards, and community vulnerabilities. The health effects of climate change are expected to have the greatest impact on children, the elderly, individuals with pre-existing conditions, and low-income communities. These populations may be more susceptible to infectious disease, have the greatest vulnerability during extreme weather events, and possess the fewest resources necessary to recover and adapt to such events. Increased exposures to fungal spores that cause valley fever in the form of increased production of allergenic pollens and mold spores, levels of dust, ozone and increase in heat-related illnesses and deaths.

D. Food & Water Borne Disease (in progress)

Water-borne diseases are a major cause of morbidity in developed countries like the U.S. Gastroenteritis originates from viral, bacterial and protozoan agents while other pathogens, such as Escherichia coli and Salmonella, are important causes of food-borne illnesses (Greer et al, 2008). Climate change, particularly events of extreme precipitation, has been associated with increases in the incidence of both water-borne diseases (Greer et al., 2008). Cholera poses the greatest climate-change threat among water-borne diseases. Such increased risk is associated with warming water temperatures (Greer et al., 2008).

E. Chronic Diseases (Drafted by the U.S.-México Border Health Commission (BHC)

Climate change can also indirectly affect individuals with chronic diseases, and while not immediately recognizable, this makes it that more important to understand and address. Extreme weather patterns can lead to increased air pollution and allergens which is widely known to trigger asthma and allergies. However, air pollution and extreme heat can also impact cardiovascular disease, with increased temperatures also leading to heat-related illnesses and even death. In addition, increases in carbon dioxide can adversely impact water and food supplies which can lead to malnutrition, diarrheal diseases, and exacerbate other chronic conditions. (Source: [HYPERLINK "http://www.cdc.gov/climateandhealth/effects/"])

The border region encompasses a large range of geographic landscapes and climate zones, however large portions of it, in each of the four U.S. border states are desert, indicating high temperatures in the spring and summer and a dry climate throughout the year. Many people find the year-round warm weather more attractive and head south either permanently or temporarily as "snow birds," however as temperatures continue to rise, the extreme heat can put people, especially older populations at risk. As populations increase in these areas, so will air pollution as commerce also increases and cities expand to meet population needs therefore potentially leading to increased rates of respiratory and heat-related illnesses (Guirgus, Gershunov, Tardy, & Basu, 2014; Gamble et al. 2013; Thomas, Swaminathan, & Lucas, 2012).

Furthermore, increasing temperatures may have a more significant impact on other climate zones in the border region including coastal areas which are traditionally milder but experience higher humidity. Populations in these areas may not be as acclimated to high temperatures and high humidity, putting them at greater risk of heat-related illnesses. Increases in heat-related illnesses and mortality rates were seen during the 2006 heat waves in California. Hospitalization rates for cardiovascular diseases and dehydration also increased during these heat waves (Guirgus et al., 2014).

As the weather warms up, especially in spring after cold winters, people like to enjoy the outdoors by swimming, hiking, playing sports, gardening, and other activities. While these are productive ways to spend time, precautions should be taken to avoid over-exposure to the sun which can lead to various forms of cancer and other skin conditions over time.

Recommendations

Educate the public on preventing heat-related illnesses through the following:

- Drinking clean water and increasing regular intake during the summer and other times of increased temperatures
- Identifying indoor activities, especially for children, during peak temperatures
- Identifying ways to protect against the sun including effective sunscreen and appropriate clothing
- Identifying what actions to take in the event of heat stroke, heat exhaustion, dehydration, or other heat-related illnesses
- Identify how individuals and communities can reduce air pollution, using models from other cities including driving in off-peak ozone times, carpooling, and utilizing public transportation

II. Community Stability in the Face of Climate Change

A. Energy Related Risks and Human Health (drafted by Laura Abram)

As of 2015, the primary fuel sources that supply the energy grid in the four U.S.-Mexico Border States were fossil fuels such as coal (AZ- 36%, NM- 63%) or natural gas (CA- 54%, TX- 53%).[1] These fuel sources help establish an affordable and reliable energy grid that is critical to delivering many of the services that form the pillars of community stability and health, including access to clean water, sanitation, and modern health services. However, in analyzing the relationship between climate change and energy production in this region, there are two key human health consequences to consider: 1) how reliance on fossil fuels for energy production directly impacts human health and climate change, and 2) how climate change may indirectly impact human health by disrupting energy production required to maintain community health and stability.

By devising a comprehensive energy strategy that addresses both a primary cause of and adverse impacts from climate change, the U.S.-Mexico Border region can also address these two energy-related threats to human health.

Direct Impacts from Fossil Fuel Use to Human Health and Climate

Fossil fuels, which have been the primary source of energy over the past century for most of the world, release air pollutants during combustion which have documented respiratory, cardiovascular, and nervous system effects. See section ### for more information on direct health impacts from fossil fuels.

Perhaps most critically, fossil fuel combustion also releases climate-warming gases into the atmosphere, which cause atmospheric and environmental changes. These atmospheric changes are now manifesting in more extreme weather patterns across the globe, including the southwestern US, which are in turn threatening power supplies and the ability to maintain a reliable energy grid.

Looking at the current and future of the energy grid in the US-Mexico Border region, communities will continue to be faced with the challenge of transitioning away from these fuel sources while both fortifying the grid against new threats from climate change and minimizing human health impacts.

Climate Change Impacts to Energy Resources in the U.S.-Mexico Border Region

Located in one of the hottest and driest regions in the U.S., the population of the U.S.-Mexico border region relies heavily on the energy grid as a lifeline to maintain habitable communities, and is therefore especially vulnerable to disruptions in electricity supply. According to several global climate change models, the Southwestern U.S. is predicted to experience higher temperatures, more heat waves, more droughts, and more extreme weather events like storms, floods, and fires over the next century[1] [1], which will serve to magnify this vulnerability. Each of these impacts pose unique threats to the energy grid and community stability and health.

1. Higher Temperatures and Heat Waves

Air temperatures in many parts of the Southwestern United States regularly exceed 100 degrees F in the summer. Climate change is expected to cause higher average air temperatures as well as increased frequency and duration of heat waves.[1] Both patterns will increase the cooling demand from homes, businesses, and thermal power plants. Combined demand increases, especially during peak-usage times, can cause overload and failure of the energy grid.

Higher temperatures also impact thermal power plants by raising the temperature of water sources. Water sources that are not sufficiently cool can cause the unsafe conditions and can reduce efficiency of the plants which require high temperature differentials to operate. Either of these conditions can force a plant to temporarily curtail production or shut down.

Additionally, high temperatures can cause stress to the physical structure of the power grid by lowering power-carrying abilities and increasing wear and tear on components.[1] This stress increases the vulnerability of the system to failure.

2. Drought

Power plants, such as hydroelectric and thermal plants (nuclear and fossil fuels), which rely on surface water for energy production and cooling are especially vulnerable to a changing climate, as water resources in the Southwest may become increasingly scarce over the next century. In a 2012 report by the U.S. Department of Energy, approximately 61% of installed energy capacity in the Southwest was considered at "high-risk" for capacity loss due to drought conditions.[1]

Insufficient water resources can cause problems for power plants in several ways. In hydroelectric plants, the generation of electricity depends on the flow of large volumes of water to spin turbines. Drops in reservoir levels cause decreased energy generation[1]. In 2014, because of severe drought conditions in California, in-state hydropower generation decreased by 50%.[1]

In thermal plants, drought conditions may impact the availability of water needed for cooling purposes. Lack of cooling water can cause unsafe conditions and lead to shutdown of plants.

3. Natural Disasters: Storms, Floods and Fires

Floods, fires and storms with high winds or lightning routinely damage electrical infrastructure. In a 2014 report by Climate Central, severe weather was determined to have caused 80% of large-scale power outages in the US between 2003 and 2012.[1] These extreme weather events and natural disasters are expected to increase in frequency and intensity in the US-Mexico Border region as global temperatures rise. Much of our energy infrastructure is located above ground and is vulnerable to severe weather. However, even power lines that are buried underground can be damaged during floods.

Power Blackouts and Impacts to Community Stability and Health

If the electricity grid is unable to meet the increasing demand brought by climate change conditions, then blackouts may occur more frequently. While many blackouts last for several hours and are considered inconvenient, there have been recent examples in the U.S., such as Hurricane Sandy in 2012, where a two-week power blackout had crippling impacts on the community. Power blackouts lasting days, weeks, or even longer, could have catastrophic impacts on the community stability and health in U.S.-Mexico Border region. Potential impacts include:

1. Heat Stroke and Deaths

In the United States, excessive heat is already the leading cause of weather related deaths.[1] California suffered a massive heat wave in 2006, which caused the deaths of an estimated 300-450 people.[1] Many low-income households in the U.S.-Mexico Border region may not have access to air conditioning and are especially at risk of heat stroke or death during power outages. See Section (###) for more information on the impacts of heat on human health.

2. Power Loss for Critical Services

Electricity powers many important services that are critical to community health and stability including water and sewer systems, communications systems, hospitals and emergency response systems, and refrigeration that preserves our food and medicines. While many of these important services have backup power generators, these generators may fail or are located in basements and vulnerable during floods, or not have enough fuel to last through a sustained power failure.[1]

The 2011 Southwest Blackout, in which power was lost in the San Diego–Tijuana area, southern Orange County, the Imperial Valley, Mexicali Valley, and Coachella Valley, and parts of Arizona, serves as an example of how power blackouts can impact community health and stability. The blackout, while caused by human-error and not climate-related, lasted for 11 hours and left nearly 7 million people without power.[1] The 11 hours without power caused an estimated $12-18 million of food losses due to spoilage, caused traffic gridlock, and caused some sewage pumping systems to fail, resulting in contaminated water supplies and some beaches.[1 1] Millions were left without air conditioning on a day in September, when temperatures in cities like Yuma reached 113 degrees F.

Recommendations for Energy Resilience

To meet the energy needs of the growing population in the border region and enhance climate resiliency, the Border States have begun to transition to a cleaner energy economy powered by energy efficiency and renewable energy programs and policies. The federal government can

continue to play a vital role through education and outreach programs, as well as providing support for the adoption of energy efficiency and renewable energy technologies.

Over the next decade, the U.S.-Mexico Border region will need to continue to invest in improvements that will ensure that the energy system can withstand the new demands brought on by climate change impacts, while providing power that is clean, renewable and affordable. Building a more resilient energy grid should be a key part of the climate change strategy for the region and will help mitigate energy-related impacts of climate change to human health.

1. Renewable Energy Sources

Investing in low-carbon energy sources is an important part of both building grid resiliency and ensuring community health and stability. In 2013, 37% percent of energy-related U.S. carbon dioxide emissions stemmed from burning coal, natural gas, and oil to produce electricity.[1] Using fossil fuels for energy production not only contributes to the greenhouse effect but also releases air pollutants like mercury, particulate matter, and sulfur dioxide into the air, which have documented health impacts.

Increased use of renewable energy not only minimizes these health impacts, but certain technologies, like wind and solar photovoltaic (PV) power, can actually improve grid resiliency by reducing dependency on fuel supplies and water for operation.[1] Wind and solar technologies are also increasingly cost competitive with conventional fuel sources (based on an unsubsidized levelized cost of energy comparison),[1] and are even more cost competitive when negative health and environmental impacts from fossil fuels are taken into consideration.[1]

Solar PV is most efficient in areas with high insolation (solar radiation that reaches the earth's surface),[1] and solar PV uses no water to generate electricity, making the technology well-suited for deployment in the U.S.-Mexico Border region. An additional benefit of solar PV is that it can be easily scaled for either residential, commercial, community or utility use. Employing a combination of distributed generation and community- or utility- scale generation will increase grid resiliency in the most cost-effective manner.

Currently, the DOE and Mexico's Secretaría de Energía are expanding power sector cooperation to include peer dialogues for grid planning and operation to include integration of renewable energy, supporting establishment of renewable energy zones in Mexico, and launching programs to enable business and investor partnerships to scale up investment in low-carbon power infrastructure. High-level government-to-government engagement, including through the U.S.-Mexico Clean Energy and Climate Policy Task Force, can continue to further these efforts.

2. Energy Efficiency and Public Education Initiatives

Encouraging the adoption of energy efficient technologies and behaviors in the public sector will also help promote grid resiliency. By reducing overall electricity demand, especially during critical times like extreme heat events, the grid will be better able to serve communities.

Since 2011, the GNEB has asked the federal government to encourage adoption of cost-effective conservation and energy efficiency technologies that benefit low-income families currently paying high prices for energy.[1] For example, EPA can encourage U.S. Border States utilizing the

Clean Energy Incentive Program as part of the Clean Power Plan to support renewable energy projects and energy efficiency in low-income communities. The U.S. Department of Health and Human Services can use its Low-Income Home Energy Assistance Program to target tribal and other poor communities in the border area, especially considering the increased number of extreme heat events and the growing need for air conditioning for vulnerable populations. In the border region of San Diego-Tijuana, cooperative efforts are underway between the U.S. Department of Housing and Urban Development (HUD) and Mexico's Secretaría de Desarrollo Agrario, Territorial y Urbano to mitigate and adapt to climate change through regional planning and green building.

Four agencies (EPA, BECC, DOE and NSF) have cooperated to assess opportunities to promote energy efficiency and distributed solar energy generation for small water and wastewater utilities along the border, including those of tribal governments. Together they held a joint workshop in April 2015 on water resource recovery facilities (WRRFs, also known as wastewater treatment plants) to stimulate dialogue and accelerate the wide-scale advent of advanced WRRFs. Most water and wastewater facilities have large pumps, drives, motors, and other equipment operating 24 hours per day, and these facilities can be among the largest individual energy users in a community. Communities that operate water and wastewater treatment plants along the border can improve energy efficiency and cost savings through the use of variable speed pumps/aeration equipment and incorporating solar power systems. Facilities also can use other approaches to improve energy efficiency by shifting energy usage away from peak demand times to times when electricity is cheaper. Wastewater treatment facilities that incorporate anaerobic digesters can use the generated biogas end product as a source of energy to operate facility booster and process transfer pumps, blowers, and heating units. The use of more energy-efficient motors and pumps will reduce further the amount of electricity needed to operate these facilities. These actions can reduce the power generation requirements of the electric power utility, thereby reducing greenhouse gas emissions.

The DOE can provide information at regional events and conferences to educate border communities on climate vulnerabilities, clean and efficient energy technologies, best practices, costs and benefits, and how to determine the potential economic and job creation impacts from implementing energy efficiency and clean energy projects, including solar PV at the rooftop, community, and utility scales. For example, energy efficiency projects create instant energy savings, create fiscal benefits, and reduce greenhouse gas emissions. Solar PV projects provide significant economic benefits, can be developed and implemented in reasonably shorter timeframes compared to wind or geothermal energy projects, and displace greenhouse gas emissions and water used by more traditional energy sources. Both energy efficiency and solar PV projects are near-term projects that federal agencies can support to help communities achieve increased climate resiliency.

In coordination with the National Weather Service, the Climate Prediction Center can use existing programs to develop methods to predict more accurately the location, length, and severity of extreme heat weather events, including events with above-average nighttime temperature, which are expected to have energy use impacts. Public education about energy efficiency and safety during these events could help prevent blackouts and heat deaths. Existing DOE, HUD, and EPA grant programs can be used to provide emergency shelters for extended

periods of extreme temperatures in vulnerable communities and subsidize air conditioning for vulnerable populations.

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B. Increased Frequency and Severity of Storms (Palacios/Jenna Kendal-under construction)

Climate change may have an impact on the duration, frequency, severity, and timing of extreme weather events (Greenough et al., 2001). There has been an increase in extreme precipitation events across the United States since the 1920s and 1930s (Kunkel, 2003). Floods are the most frequent type of natural disaster in developed and developing countries around the world (Ahern, Kovats, Wilkinson, Few, & Matthies, 2005). Flash floods are generally more dangerous than floods that have a slower onset (Ahern et al., 2005). Flooding is influenced by multiple variables including soil moisture, intensity and length of time of the precipitation event, slope of terrain, and the development of impervious surfaces (roads, buildings, sidewalks, parking lots) (Gourley, Erlingis, Hong, & Wells, 2012).

The Impact on Human Health

Flash flooding is the top storm-related cause of death in the United States (Gourley et al., 2012).

The direct health impacts of extreme weather events include death, injuries, fecal-oral transmission of disease, vector and rodent-borne disease. Mortality is a frequent health impact of flash floods, with deaths often occurring suddenly by drowning or being struck by objects in flood waters. Flood deaths are commonly related to vehicles being swept away by swift moving flood waters, with men being the most common (Ahern et al., 2005). The elderly are most vulnerable to drowning inside their own homes (Ahern et al., 2005). Flooding brings increased risk of waterborne disease, dehydration from decreased access to potable water, and exposure to mosquitos and other vectors (Greenough et al., 2001).

Indirect impacts include illnesses related to the social and ecological disturbance (Greenough et al., 2001). Increased incidence of mental health issues have been documented following flood and other natural disasters, in particular anxiety, depression, post-traumatic stress disorder, and stress (Ahern et al., 2005). Disruption to the normal routines can indirectly impact health. These indirect impacts can include illnesses that result from decreased access to medical care and medications, carbon monoxide poisoning caused by use of electric generators during power outages in the aftermath of storms, and increases in gastroenteritis cases (Mills, 2009).

The Impact on the Border

Climate change will likely lead to variability within the region with some areas receiving extreme precipitation, while others experiencing drought (Collins et al., 2013). The U.S.-Mexico Border region is at risk of multiple natural disasters, including flooding, hurricanes, tornados, and earthquakes. Much of the border region is desert and anything more than normal precipitation can result in severe flooding. Flash floods are a common event during extreme precipitation in the arid environments and a major cause of erosion (Foody, Ghoneim, & Arnell, 2004).

Soil erosion is impacted by lack of vegetation in the arid environment. Plant cover acts as an intercept of rainfall from directly impacting the ground, roots help with infiltration of water, and help root soil in place (Zuazo & Pleguezuelo, 2008). Rain that exceeds the infiltration rate of the soil results in run off water and erosion. Soil erosion is typically driven by water and is aggravated by human activities, such as altering land cover, land use development, and cultivation of soil (Yang, Kanae, Oki, Koike, & Musiake, 2003). During periods of heavy rainfall, the arid desert region is at higher risk of soil erosion and water run off (Zuazo & Pleguezuelo, 2008).

Border communities are likely to have difficulty coping with flash flooding.

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C. Wild Fires

Climate changes have given rise to temperature increases, higher Carbon Dioxide (CO2) levels, and strong variating patterns of precipitation –affecting U.S. water resources, agriculture, land resources, and biodiversity (US Climate Change Program, 2008). The accumulation of CO2 within the atmosphere presents a particularly difficult challenge within the border region, influencing natural disturbance systems, and feedback mechanisms that regulate species diversity. Natural ecosystems and levels of biodiversity are driven at least in part by the species sensitivity to rising atmospheric CO2 (Smith, et. al., 2000), altering the frequency and seasonal cadence of wildfires, reducing establishment of perennial herbaceous species by dehydrating soil of water early in the growing season (Young et.al, 1991). Border regions are typically characterized as arid landscapes, very likely do not have a large capacity to absorb CO2 from the atmosphere and will likely lose carbon as climate-induced disturbance increases (US Climate Change Program, 2008). Climate change in arid lands will create physical conditions conducive to wildfire, and the proliferation of non-native grasses and shrubs will provide fuel, thus causing fire events to increase in frequency and velocity (US Climate Change Program, 2008).

In some regions, changes in temperature and precipitation are projected to increase the frequency and severity of fire events. Large wildfires release large amounts of fine particulates (PM2.5), causing PM2.5 concentrations to reach levels as high as 10-20 times the national ambient air quality standard (NAAQS) in adjacent populated areas. Wildfires also release large amounts of VOCs and semi-volatile organic compounds, which contribute to the formation of secondary organic aerosols (SOAs). Elevated concentrations of PM2.5 and SOAs cause by wildfires are usually accompanied by an increase in the number of people with respiratory problems, such as asthma and chronic obstructive pulmonary diseases, to seek treatment at a hospital.

In addition, forests are not managed properly. Too much fire suppression, clear cutting, and conversion of old forests to tree farms. Address this with new agroforestry systems that are more sustainable and resilient.

Recommendation:
Avoid building human settlement in what constitutes wildfire corridors (areas subject to large scale fires due to human as well as natural causes).

Promote a more sustainable form of agroforestry and defensive measures-- (wind breaks, shelter belts, riparian buffers, etc.). At the same time, don't suppress fires to an extent that excess biomass accumulates creating dangerous conditions.

Support USDA and DOI efforts to improve forest conservation and retention, in "climate-smart" ways that advance carbon mitigation and adaptation.

Increased funding, more availability of funding for vulnerable and disadvantaged communities to establish infrastructure and build capacity for fire suppression, emergency management implementation, and hazard mitigation for natural disaster events.

Increased funding for forest management for wildland fire management, which would be specific to rural disadvantaged vulnerable communities. Administration of Federal Programs to Protect

Tribal Resources. In order to meet its trust responsibility to tribes, the federal government should operate government programs to protect treaty and other tribal rights in light of climate change impact.

D. Food and Water Security (Draft by Lauren Baldwin/Keith Pezzoli)

Some scientists have suggested that the biggest threat posed by climate change is to the breakdown of food systems (Pezzoli, 2015). Drought and agricultural water shortages affect various counties in Texas, New Mexico and Arizona and various municipalities in Mexico. Mexico grows a significant amount (60%) of the produce sold in the U.S. and as such, this country is critical to the American food system (Hungry for Change, 2012). Recent reports suggest that climate change has affected approximately 70% of Mexico's agricultural surface through land desiccation and degradation. Recent years have seen millions of acres damaged by drought, freezes, and catastrophic weather events resulting in significant crops and livestock loses. Oceans and rivers are also significantly impacted through climate change, resulting in high seafood losses. Environmentally sustainable food systems are becoming scarcer with growing climate changes.

The impact of climate change on our food systems will result in significant increases in food insecurity, particularly among poor populations, which are abundant in most of the border region. Food prices will continue to increase to historical highs and the poor will feel the greatest impact in terms of food insecurity and malnutrition. Reduction in access to healthy foods, such as fruits and vegetables, meat, and fish has resulted in an increased reliance on non-perishable, high caloric and low nutrient dense foods contributing to the obesity epidemic on the U.S. Mexico border. Considering that this border region currently reflects what a large part of the entire US will look like by 2050 (Soden, 2006), it is imperative that multiple agencies, including the U.S. government, intervene in this environmental, economic, healthcare, and humanitarian crisis. Failure to curtail the environmental crisis and obesity epidemic so strongly impacting the border population, particularly Mexican Americans and Native Americans, will inevitably lead to increasing trends in obesity-related chronic diseases like diabetes, hypertension, and cancer (Palacios et al., 2012).

As mentioned previously, it is clear that carbon dioxide levels, temperatures, and ultraviolet levels are increasing. The rising carbon dioxide levels have many effects, including increasing the carbon to nitrogen balance in plants: "Rising carbon dioxide will increase the carbon-to-nitrogen balance in plants, which in turn will affect insect feeding, concentrations of defensive chemicals in plants, compensation responses by plants to insect herbivory, and competition between pest species" (Trumble). In addition, increases in temperatures can change the area in which insects are normally found. For example, the mountain pine beattle "extended its range northward by approximately 186 miles" with a temperature increase of 3.5 degrees F (Trumble). Ultimately, with the change of climate, farmers will experience challenges with new invasive species and pests.
Unless integrated pest management strategies are implemented and local farmers along the U.S.-Mexico border are trained, farmers could experience a decrease in yields as a result of these changing pest outbreaks.

Though plants grow better when exposed to higher carbon dioxide levels, pests also tend to eat more when plants are growth with higher levels of CO2: Early research in California demonstrated that while lima beans (Phaseolus lunatus) did photosynthesize better and grow more rapidly in higher concentrations of carbon dioxide, their primary pest, the cabbage looper, also ate about 20% more leaf area (Trumble). Pests need nitrogen, so they ate more leaf area to get the same amount of nitrogren in these higher-carbon-containing leaves. Farmers can counter this by adding nitrogen to their crops, but this comes at an additional cost and can affect the aquatic life in adjacent water bodies.

In California, farmers should expect to not only see the range of insects expand into new areas, but also increased population levels of some pesky insects and the arrival of new pests (Trumble). The increase in temperature has led to some pests staying longer (since the cool temperatures usually cause them to retreat to warmer areas: "the potato psyllid migrated into California again in 1999 or 2000, and has since established large, year-round populations as far north as Ventura County that have persisted for the last 7 years. The tomato, potato and pepper industries have suffered substantial losses as a result" (Trumble).

Recommendations:

- Transborder dependence in the U.S. and Mexico food systems requires transborder cooperation in addressing climate impact.
- Develop a network of community gardens, food forests and backyard growing spaces.
- Conduct ecological research to determine ways in which we might improve the efficiency/effectiveness of natural treatment systems (e.g., bioretention designs including bioswales, biofilters, rain gardens) in community gardens and food forests.
- Enhance public/community knowledge about the importance of healthy terrestrial ecosystems, including the vital role plants and microbial soil communities play in sustaining life, and food production in environments stressed by climate change.
- Develop an edible plant tissue testing program to quantify and monitor over time any heavy metal accumulation that may be taking place in the edible tissues of plants and trees (e.g. fruits) people are growing for food in disadvantaged neighborhoods. Toxic heavy metal and arsenic accumulation in edible plant tissues is a problem facing millions of people around the world leading to cancer and other diseases.
- A more equitable border food system that supports public health by generating alternative food networks
- Increase/support resiliency of food producing landscapes

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E. Direct and indirect health impacts

Extreme weather events, which are occurring more and more frequently as a result of climate instability, have many different types of impacts on human health. These impacts can be categorized as direct and indirect, and both need to be considered in planning for and responding to extreme weather events. Direct health impacts include injury or death caused from structural damage (drowning during a flood, heat exhaustion, etc.) and also mental health disorders such as depression and post-traumatic stress disorder (Mills). Indirect health impacts are caused by a disruption of normal routines after an extreme weather event, which can lead to a multitude of unexpected consequences, such as carbon monoxide poisonings from the use of portable electric generators. Also, when residents are displaced, it is often difficult for them to obtain their regular medical services or medicines, which can cause many other problems (Mills).

The underlying stresses in a community, in addition to the severity and unexpectedness of a storm, can greatly affect the number and type of direct and indirect health impacts from an extreme weather event. As an example, in El Paso, the Office of Emergency Management currently has a 48 hour - 72 hour notification window for extreme heat. Having a reliable warning system that gives El Pasoans more time to prepare and support residents would result in fewer negative health impacts. In addition, the underlying stressors, low education levels and low income levels, decreases residents' ability to prepare as needed (i.e. purchase fans or air conditioning units). If the mild to moderate signs and symptoms of heat exhaustion go untreated, they can progress into heat stroke, so it is very important to support the development of social networks, such as neighborhood associations and community groups to increase social cohesion and connectivity so early signs of heat exhaustion can be detected and treated.

Recommendations: Lauren Baldwin

"Climate change will likely increase the health risks presented by hurricanes, extreme precipitation/floods, and wildfires in the United States in the coming years. Responding to this increased risk requires a commitment of human and financial resources" (Mills).

Provide staff in Emergency Management Departments across the U.S.-Mexico border to implement early warning systems and provide the marketing dollars needed to reach diverse audiences about what they need to prepare adequately: "A survey of individuals aged >65 years in four North American cities found that, whereas community knowledge of heatwave advisories was high, knowledge about appropriate preventative actions was low" (Luber). Funding should be provided to support the development and deployment of public information materials, such as public service announcements, billboards, flyers, and radio ads, which can educate the public about appropriate preventative actions. Because there is a "2-to 3-day lag" in mortality after the start of a heatwave, it can be difficult to communicate the importance and impact of a heatwave, thus education is strongly needed.

Support heat-wave response plans, which are "written plans that detail actions local government agencies and non-govermnetal organizations can take when extreme heat is predicted" (Luber). Support marketing efforts to increase public recognition of extreme heat as a serious issue, despite its "silent killer" perception. Support community building activities—support

AmeriCorps members that help develop social ties and support networks, especially among the most vulnerable (elderly, those living alone, people without access to air conditioning, and people with chronic mental disorders or pre-existing medical conditions (Luber)). The goal is to increase the number of daily contacts for the elderly and other vulnerable residents, especially during extreme heat events.

Fund the establishment of emergency cooling shelters for respite: "Even a few hours spent daily in an airconditioned environment has been shown to be a strong protective measure in reducing heat-related illnesses and death" (Luber). Fund AmeriCorps volunteers who are trained to recognize heat-related hazards and recognize the symptoms or heat-related illnesses, who can teach community leaders and residents. "U.S. cities, with few exceptions, are not adequately prepared for heatwaves" (Luber). Fund the expansion of Low Income Home Energy Assistance Programs to provide energy assistance not only during cold months, but during hot months as well: "in 2007, only 16 states offered cooling-related energy assistance programs under LIHEAP" (LIHEAP Program Duration). As reported by Sheridan and colleagues, cost was a factor for a third of survey respondents in deciding whether or not to run the air conditioning in their home during hot months (Sheridan). For those vulnerable, low-income, and fixed-income residents, air conditioning might come second to food or medicine, especially since the public perception of the severity of heatwaves is distorted.

Provide direct training to local governments' capital improvement, engineering, planning, and streets departments about the importance of integrating "cool cities initiatives," including cool pavements, roof-top plantings, green stormwater infrastructure, tree plantings, and increasing green spaces in urban areas. Provide direct funding to cities to replace low-albedo surfaces with high-albedo surfaces during routine maintenance of roads and buildings (Luber). Embed planning stuff to pass local ordinances to require "cool" roofs on all new residences (Los Angeles passed this building code amendment in 2013) and provide guidance for business owners (Krueger). Provide direct training to City and County Health Directors and team members about how to assess health impacts and address climate change impacts on local residents: "Despite these recognizable threats, a study by the National Association of City and County Health Officials (NACCHO) shows that while 8 out of 10 health directors surveyed believe that climate change is occurring, 76% of directors do not believe they have the expertise to assess health impacts within their community, and 87% do not believe they have sufficient resources to address climate change impacts on local residents" (Krueger). Provide direct funding to planning offices and resilience offices to contract with researchers who can create heat vulnerability maps to ensure local governments are focusing their efforts on the most vulnerable.

Assign a federal employee to sponsor and lead a symposium for building owners, commercial realtors, HVAC contractors, consultants, and healthcare professionals, focused on heat-health and proper maintenance of cooling towers during periods of nonuse. This is important because the increased variability in temperatures can cause some cooling towers to become sustainable to Legionella bacteria colonization and biofilm development, which can cause contamination and respiratory infection, as seen in Milwaukee County in 2013 (Krueger). Support local HVAC industry standards to reflect proper maintenance that promotes improved health despite changing temperatures.

Fund research in agricultural universities to support the modification of integrated pest management techniques. As temperatures and pest species composition change, new biocontrol agents will need to be researched in order to prevent major pest outbreaks. In addition, as the U.S.-Mexico border cities experience more frequent drought conditions, there will be a need to research drought-resistant cultivars (Trumble). As border cities experience urbanization and a decrease in agricultural yields, there will be a shift away from local food production and a shift towards importing food from overseas.

Provide direct funding for community gardens, school gardens, gardens on restaurant and business property, church gardens, library gardens, etc. in order to encourage local food production and a sustainable urban food system. In addition, it is important to provide funding to support staff to implement community gardens and train local garden leadership because strong leadership and organization is crucial for the sustainability of community gardens or urban food forests. In addition, funding should be provided for education and marketing efforts to promote learning about the value of local food production.

F. URBANIZATION AND CLIMATE CHANGE

The rapid population growth on the U.S. Mexico border has significant implications for the border environment. Associated with the large population growth are poverty and environmental degradation along the border. Population growth is expected to continue on the border, at a rate exceeding that of the nation overall, and will result in significant environmental demands, such as:

- High-energy consumption contributing to poor air quality & respiratory disease
- Population growth will exceed water availability; competition between domestic and agricultural water demands will impact food systems.
- Waste-disposal problems and impact on water quality will contribute to multiple health hazards
- Automobile exhaust contributes to elevated lead levels in the air and to particulate contamination impacting respiratory health, particularly among vulnerable populations (children, poor, elders)
- Urbanization is associated with decreased physical activity and poor nutrition, contributing further to chronic disease such as diabetes, heart disease, and cancer.
- Animal populations will also be impacted by toxic substances, vehicles, loss of habitat & food sources
- Climate refugees need to relocate due to rising temperatures, insufficient water and food resources, and toxic environment

Industry and agricultural practices on the border also contribute to contamination of water, air, soil. For example use of fertilizers and chemicals along with multiple dairies lead to contaminated run-off into the region's limited water systems (e.g., nitrates, lead; pesticides, etc.). Such contamination is toxic to human body and may result in poor health outcomes such as decreased kidney/liver function; decreased mental & motor skills; birth defects, cancer and others, especially among vulnerable populations.

Recommendations:

- Strong city planning is necessary to address the environmental impact resulting from large population growth on the border
- Economic development and job creation is needed to combat poverty
- Alternative/upgraded energy sources
- Increased public health efforts
- Greater federal/state level environmental surveillance/remediation efforts
- Greater federal support for border environmental research

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III. Vulnerable Populations (in progress)

A. Native Communities and Climate Change: Protecting Tribal Resources as Part of National Climate Policy

While climate change will affect everyone, it will impact some disproportionately. Native American communities are among the most vulnerable. Climate change threatens tribal culture, resources, and ways of life. For this reason, it is imperative that Congress and executive branch agencies consider the special threats and disparate impact faced by tribes. Ample authority exists to support such consideration. In particular, the federal trust responsibility requires the federal government to protect tribal land and resources. This authority is rooted in numerous treaties, statutes, executive orders, and judicial opinions that recognize the very tribal rights at risk from climate change.

Climate change is a global phenomenon and will affect everyone under even the most conservative future scenarios. However, a changing climate will not affect everyone equally. Native communities are particularly vulnerable, and the adverse effects of climate change will fall disproportionately on tribes even though their contributions to the problem are usually negligible. Tribes are often the first to see, and the first to feel, changes in the natural environment. Traditional tribal practices and relationships with the natural world form the spiritual, cultural, and economic foundation for many Native American nations—foundations that will be, and in some cases already are, threatened by climate change. Alaska Natives provide perhaps the most compelling illustration of the harm that native communities already face from climate change. For centuries, the Colorado River and its tributaries have been the lifeblood of southwestern tribes, including the Hopi, Navajo, Mohave, Apache, Tohono O'odham, and others. Historically plentiful waters enabled tribes to survive in this arid region by growing crops and raising livestock, traditional subsistence practices that many tribes still follow today. A dramatic increase in the population of the Southwest has placed a severe strain on the water resources in the Colorado River basin. Today's users place such high demand on the river system that in most years the Colorado does not reach its outflow into the Gulf of California. Nor does this trend show signs of stopping. Nevada and Arizona alone are expected to double their population in the next 25 years. Tribes often hold federal reserved water rights that are among the most senior in the prior appropriation scheme of water allotment in the West. Yet many tribal water rights remain unquantified and tribal access to water rights is often impeded by the lack of infrastructure. In a warmer and drier Southwest, competition for water resources will only become more fierce, posing significant challenges for tribes, and also threatening the already unstable and delicate allocation for all southwestern residents. Recent drought conditions seen on the Gila River. Water scarcity due to climate change in the Southwest will only exacerbate existing pressure. Increased demand for decreasing water supplies will have serious implications for tribes, as competition between tribal and non-tribal users will make water adjudication and negotiation more difficult.

CONGRESS AND EXECUTIVE AGENCIES SHOULD ACT TO ADDRESS CLIMATE CHANGE IMPACT ON TRIBES

A number of factors compel the federal government to take action to address the severe and disparate impact that climate change will have on native communities. At the heart of this obligation is the trust responsibility, which requires the federal government to protect tribal land and resources. Moreover, many aspects of tribal culture—for example, subsistence practices and

water rights for tribal lands—have long been recognized and protected by treaties, statutes, and judicial decisions. If, as predicted, climate change makes water and other natural resources more scarce, tribal protection of these interests could pose significant problems for current patterns of use and consumption by non-tribal parties, thereby requiring federal intervention. Addressing the causes of climate change and adapting to its consequences will not come cheaply. For this reason, the federal government must recognize that climate policy will only be effective if it generates the substantial sums of money these efforts will require.

Trust Responsibility.
The federal government has a unique trust relationship with American Indian tribes. This relationship, which is embodied in thousands of treaties, statutes, and executive orders and recognized in countless judicial opinions, provides Congress with the authority to pass legislation that will address the specific effects of climate change on American Indian communities. In some particular circumstances where tribal rights are threatened by climate change, the trust responsibility may create a legal obligation requiring the government to act. While courts are often reluctant to order the federal government to take specific actions pursuant to the trust responsibility, there have been occasions where rights to both damages and injunctive relief have been recognized. Furthermore, judicial caution in enforcing the trust obligation does not lessen the federal government's legal and moral responsibility to take action when tribal land and resources, which form the basis for tribal sovereignty, face threats as serious as those from climate change. The trust responsibility should also encourage federal agencies to interpret and apply statutory and administrative climate change policies for the benefit of native communities.

Treaty Rights.
Rights to land, water, fish, and wildlife guaranteed by treaties, as well as other solemn legal commitments with tribes, impose a clear duty on the federal government. As tribal resources are threatened by changing climate, the federal government has an obligation to take action.

Environmental Justice.
Climate change raises many issues of fairness and justice to tribes. As noted previously, for example, Alaska Natives following traditional subsistence lifestyles contribute virtually nothing to climate change yet suffer some of its most serious effects. Disappearing sea ice, rising sea levels, changing weather patterns, higher temperatures, and other factors threaten to destroy native villages and many of the plant and animal species upon which these people depend. An Executive Order signed by President Clinton in 1994 requires each federal agency to work to achieve environmental justice in agency policies and regulations. While the Order is not enforceable in court, federal agencies have subsequently incorporated considerations of environmental justice in their operations. If principles of environmental justice mean anything—and, in light of the federal trust responsibility, they should—then the government must use them to help shape federal climate change policy.

Adequate Revenue-Raising Mechanism. While debate continues over a wide range of legislative initiatives, none of the current proposals will likely generate the substantial revenues needed to finance mitigation and adaptation efforts in response to climate change. Mitigation and adaptation will be costly. As described in the case studies, certain native communities will be especially affected. Any national climate policy to address the impact on tribes must provide a

substantial revenue-raising mechanism if it is going to be adequate

Alternative Energy Development Funding for Tribes.

Because fossil fuel emissions are such a major contributor to climate change, development of alternative energy technologies will be an important component of any future strategy. Tribes have some of the greatest resources (e.g. wind and solar power) for helping the nation with renewable energy development. At the same time, they are among the most vulnerable to impact from climate change caused in large part by conventional fossil fuel-based energy development. Helping tribes develop alternative energy technologies both on reservations and as part of a national renewable energy program can help overcome this contradiction. Alternative energy projects take investment capital, infrastructure, and technical capacity that tribes often lack. Development of renewable energy resources by tribes on their own will do little to mitigate the impact from climate change on their communities. However, tribes can play an important role in any national or international solution. For this reason, any renewable energy program at the federal level must include opportunities and incentives for tribes. Such a program should include technical assistance and subsidies for individual projects on reservations. The government should also provide financial assistance to establish transmission lines to connect tribal projects to the national energy infrastructure.

Administration of Federal Programs to Protect Tribal Resources.

In order to meet its trust responsibility to tribes, the federal government should operate government programs to protect treaty and other tribal rights in light of climate change impact. This may implicate many programs not particularly directed at tribes. But national mitigation efforts that benefit tribes will benefit everyone. Recently, the Supreme Court recognized that the Environmental Protection Agency has the authority to regulate greenhouse gases from automobile emissions. A subsequent Executive Order asks the agency to implement regulatory measures soon. In setting the level and extent of greenhouse gas regulation, the EPA should take into account the trust obligation that the federal government owes to tribes, as well as the environmental justice executive order and the need to address the disproportionate impact to tribes.

CONCLUSION

As the latest report from the IPCC makes clear, our climate is changing in significant ways. While all of us will certainly be affected to some degree, some will bear disproportionate impact from climate change. Among those disparately affected are native communities. Their traditional lifestyles typically contribute little to the causes of climate change even as the change fundamentally harms tribal culture and the close relationship tribes have with the land, water, wildlife, and other natural resources. Congress and executive agencies must act to address and resolve climate impact on tribes to fulfill the federal trust responsibility, as well as obligations under treaties, statutes, executive orders, and common law doctrines. If they fail to do so, tribal enforcement of these rights in the face of increased scarcity and competition could well force the government's hand. As legislators begin to craft national policy on climate change, it is essential that they fully understand and address the impact on native communities.

This report makes several recommendations to that end:

- Congress should hold hearings on the impact of climate change to tribes, as well as provide

opportunities for meaningful and continued input from tribes into national climate policy and programs. • National climate policy must include an adequate revenue-raising mechanism to finance the costly adaptation and mitigation efforts necessary to address disparate impact on tribes.

• The federal government must provide alternative energy development funding and technical assistance for tribes.

• The federal government must administer federal programs to protect tribal resources.

Reference Document:

Native Communities and Climate Change: Protecting Tribal Resources as Part of National Climate Policy

A Report Published by the Natural Resources Law Center at the University of Colorado Law School In Conjunction with the Western Water Assessment at the University of Colorado

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